The Short Duration Premium

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Abstract

Stocks of firms with cash flows concentrated in the short-term (i.e., short duration stocks) pay a large premium over long duration stocks. I empirically demonstrate this premium: (i) is long-lived and strong even among large firms; (ii) subsumes the value and profitability premia; and (iii) exposes investors to variation in expected returns, especially in times when the premium is high. These facts are consistent with an intertemporal model in which the marginal (long-term) investor dislikes expected return declines as they lead to lower expected wealth growth. The model also captures the positive relation between risk premia and bond duration.

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Introduction

Linking asset prices to properties of cash flows is at the heart of the asset pricing research agenda. But what cash flow characteristics matter and how are they connected to asset prices? Recent literature indicates that cash flow maturity is an important characteristic and is connected to asset prices through a downward sloping term structure of risk premia beyond the first few years (see Binsbergen and Koijen (2017) for a literature review). The relatively low risk premia of long-term risky cash flows have important implications for the cross-section of stock returns and exploring these implications is of fundamental importance for our understanding of asset prices.

This paper sheds light on this issue by studying equity portfolios sorted on cash flow duration, which effectively ranks stocks based on whether firm value is concentrated in short- or long-term cash flows. I find a strong premium for short duration stocks and show that several of its properties are consistent with this premium existing in equilibrium because earning it requires exposure to reinvestment risk, which is undesirable from the perspective of long-term investors.

To start, I develop and apply a novel firm-level measure of equity duration and find that, from 1973 to 2017, short duration stocks paid a large premium (9.2% per year in value-weighted decile portfolios) relative to long duration stocks despite having lower market betas. This finding is consistent with the literature (Dechow, Sloan, and Soliman (2004), Lettau and Wachter (2007, 2011), and Weber (2018)) and represents the starting point for my analysis.

I provide two new empirical facts about the short duration premium. First, the premium is long-lived (lasts for at least five years) and is strong even among large firms (market equity in the highest NYSE quintile). Second, after controlling for duration, the value (Fama and French (1993, 1996)) and profitability (Novy-Marx (2013)) premia disappear and this result is stronger if value, profitability, and duration are all included in joint tests. Intuitively, if two firms have different growth opportunities, but the same profitability, the one with less growth opportunities (the value firm) will save/invest less and pay more of its resources over the short term, becoming a short duration company. Similarly, if two firms have different profitability, but similar growth opportunities, the more profitable one will have more resources to distribute to investors in the near future and become a short duration firm.

These new empirical facts suggest that the value and profitability premia are proxies for the short duration premium, which does not resemble an anomaly that concentrates in small stocks and quickly disappears. Consequently, understanding the fundamental driver of the short duration premium can help us better understand the cross-section of stock returns.

In this vein, I provide a novel explanation for why the short duration premium exists in financial markets. First, I build on the Intertemporal CAPM of Campbell (1993) to argue that long-term investors care about long-term wealth, and thus price market risk (i.e., variation in current wealth) as well as reinvestment risk (i.e., variation in expected wealth growth). Second, I empirically show that investors can only earn the short duration premium by being exposed to substantial reinvestment risk. Third, I demonstrate that this reinvestment risk exposure is large enough to explain the short duration premium observed empirically with plausible estimates of relative risk aversion.

The reinvestment risk exposure of the short duration strategy originates from a simple mechanism. Decreases in expected wealth growth are induced by lower expected returns, and thus are associated with increases in equity prices through lower discount rates. Since longer duration stocks are more sensitive to discount rates, their prices increase by more when expected wealth growth declines, inducing negative returns on the short duration strategy. Consequently, the short duration strategy is strongly exposed to reinvestment risk.

To complement the cross-sectional evidence, I also explore the time-series dimension. I find that the short duration premium is substantially larger in periods in which earning the premium requires higher exposure to reinvestment risk. In particular, I argue that larger cross-sectional dispersion in equity duration induces higher reinvestment risk for the short-duration strategy given the larger duration spread between sorted portfolios. Consequently, we should observe a larger premium in periods with higher cross-sectional dispersion in equity duration if reinvestment risk is its main driver. Consistent with this hypothesis, I find that the short duration premium is much higher in periods with higher cross sectional dispersion in equity duration (20.8% vs 4.8%). Moreover, the reinvestment risk of the short duration strategy is also much larger during these periods, which provides a time series link between the short duration premium and reinvestment risk.

It is natural to wonder whether capturing the short duration premium comes at the cost of producing higher risk premia for shorter duration bonds, which would be counterfactual. This is not the case; I find that the reinvestment risk mechanism helps generating risk premia that increase in bond duration for government and corporate bonds. This result is a consequence of the negative correlation between nominal interest rates and equity expected returns (Fama and Schwert (1977), Campbell (1987), Ferson (1989), Shanken (1990), Brennan (1997), and Cederburg (2019)). Specifically, interest rates rise and bond prices fall as expected returns decline and this effect increases in bond duration, inducing higher reinvestment risk for longer duration government and corporate bonds.

In summary, I develop a novel measure of equity duration and use it to study the short duration premium extensively. I find that this premium is observed even among large firms, lasts for a long period, and dominates the value and profitability premia. Moreover, I show that several of the short duration premium properties are consistent with the hypothesis that this premium exists because earning it requires exposure to reinvestment risk, which is priced by long-term investors.

This paper is broadly related to the recent literature on the term structure of dividend risk premia (see Binsbergen and Koijen (2017) for a literature review) as I study the connection between the downward sloping term structure of dividend risk premia and the cross-section of stock returns.[1] In particular, Gonçalves (2018) shows that reinvestment risk explains

[1] This dividend term structure literature builds on Brennan (1998)'s insight that variation in divided prices provides an important signal for changes in the fundamental value of cash flows. Binsbergen, Brandt, and Koijen (2012) use option prices and the put-call parity to show that claims on S&P500 short-term dividends have higher average returns than the index itself, which is a long duration portfolio of dividend claims. Binsbergen and Koijen (2017) study dividend futures contracts and find similar results while Binsbergen et al. (2013) emphasize the procyclicality of the term structure of hold-to-maturity risk premia and Gormsen (2018) shows countercyclicality of the term structure of 1-period holding returns. Cejnek and Randl (2017) and Li and Wang (2017) further explore the predictability power of dividend prices and Cejnek and Randl

the dividend (and bond) term structures of risk premia and I build a bridge between the dividend term structure and the cross-section of stock returns by demonstrating that the same mechanism helps to explain the short duration premium.

This paper is also connected to the literature linking cash flow duration to asset prices (Dechow, Sloan, and Soliman (2004), Lettau and Wachter (2007, 2011), Hansen, Heaton, and Li (2008), Da (2009), Chen (2011), Weber (2018), Chen and Li (2018), and Gormsen and Lazarus (2019)). My measure of equity duration (*Dur*) is most closely related to the equity duration measure in Dechow, Sloan, and Soliman (2004) (*DSS Dur*). In Section 4, I provide a comparison between *Dur* and *DSS Dur* to demonstrate that, despite *DSS Dur* being an important first step, *Dur* substantially improves upon it on theoretical and empirical grounds.

Weber (2018) is the closest paper to mine in terms of the objective of better understanding what drives the short duration premium. He studies duration sorted portfolios based on *DSS Dur* and argues that market participants are overly optimistic about the prospects of long duration companies, inducing overvaluation for these companies, which leads to poor returns. While I provide a direct link between equity duration and reinvestment risk both in the cross-section and in the time-series, Weber (2018) links equity duration to mispricing (also on both dimensions). In Section 4, I discuss the relation between the two papers and argue that reinvestment risk and mispricing are complementary channels that help capture the short duration premium. Specifically, reinvestment risk justifies the existence of a short duration premium in the absence of mispricing while mispricing generates a larger short duration premium among stocks that are more subjected to mispricing.

The result that the value premium disappears after controlling for duration is predicted by the prominent theoretical framework presented in Lettau and Wachter (2007, 2011). However, I empirically demonstrate the underlying cash flow risk mechanism proposed in these papers does not perform well empirically in explaining the short duration premium I

(2017) relate the dividend term structure to an options-based downside risk factor. Manley and Mueller-Glissmann (2008) and Wilkens and Wimschulte (2010) provide valuable institutional details about the market for dividend derivatives.

observe in the data, especially its time variation. Of course, one of the main appeals of the framework in Lettau and Wachter (2007, 2011) is that it combines elements of structural models with aspects of reduced form models, and thus is flexible enough to incorporate new effects. As such, exploring adjustments to this framework that capture different asset pricing phenomena (including the time variation in the short duration premium) remains a fruitful research agenda.

My findings are also related to the ICAPM literature.[2] The paper closest to mine in this literature is Campbell and Vuolteenaho (2004). They empirically show that the value premium can be explained by the ICAPM of Campbell (1993). The cross-sectional link between reinvestment risk and equity duration I find is theoretically expected once we combine the empirical results in Campbell and Vuolteenaho (2004) with the theoretical argument that we should observe a strong correlation between equity duration and valuation ratios (Lettau and Wachter (2007, 2011)). My paper adds to these previous papers by exploring this cross-sectional link empirically and by showing that, after controlling for duration, the value and profitability premia both disappear. I also add to the previous literature by providing evidence that connects the time-series variation in the short duration premium to reinvestment risk. Finally, my empirical results build a direct bridge between equity duration and the term structure of dividend risk premia as reinvestment risk can explain both phenomena.

Two contemporaneous and independent working papers (Chen and Li (2018) and Gormsen and Lazarus (2019)) also demonstrate the link between duration and other cross-sectional asset pricing anomalies (such as value and profitability). Despite this similarity, our papers are fundamentally different. While I focus on understanding the intrinsic driver of the short duration premium, Chen and Li (2018) and Gormsen and Lazarus (2019) take the short-duration premium as given (as a risk factor) to summarize the cross-section of stock returns. Gormsen and Lazarus (2019) further demonstrate that the link between equity duration and

[2]The ICAPM was first proposed by Merton (1973) and a closely related discrete version was developed by Campbell (1993), which is the framework I build on. Given the long history of the ICAPM, many papers empirically tests and/or further develop the model. Some examples are Campbell (1996), Ferson and Harvey (1999), Brennan, Wang, and Xia (2004), Campbell and Vuolteenaho (2004), Petkova (2006), Campbell, Polk, and Vuolteenaho (2009), Bali and Engle (2010), Campbell et al. (2017), and Cederburg (2019).

several anomalies is a natural outcome of the model in Lettau and Wachter (2007).

The rest of the paper is organized as follows. Section 1 provides details on my equity duration measure and the empirical design. Sections 2 and 3 explore the short duration premium and its relation to reinvestment risk in the context of the ICAPM. In turn, Section 4 studies other equity duration measures and Section 5 concludes. The Internet Appendix contains technical derivations, empirical details, and supplementary results.

1 Empirical Design

This section details the definition and measurement of equity duration and provides some basic information on the sample construction, including the duration sorted portfolios later used to study the implications of equity duration to the cross-section of stock returns. Technical derivations are provided in Internet Appendix A.

1.1 Equity Duration

I define equity duration analogously to the common concept of bond duration (Macaulay (1938)) and demonstrate how it can be solved for under the assumption that (log) profitability and growth evolve linearly. To simplify exposition, I omit the firm index, j, from all expressions despite using the results in this subsection to estimate duration that varies both over time and across firms.

a) Definition

Duration is a concept often used to capture the average maturity (in years) of cash flows associated with a given investment. In general, duration is defined as:

$$Dur_t = \sum_{h=1}^{\infty} w_t^{(h)} \cdot h \tag{1}$$

where $w_t^{(h)} = (\mathbb{E}_t\left[CF_{t+h}\right] \cdot e^{-h \cdot dr_t})/V_t$ with V representing the investment value, CF its cash flows, and dr its discount rate.

Intuitively, $w_t^{(h)}$ tells us the fraction of the investment value that is due to the cash flow maturing in h years. As such, ws are weights ($\sum_{h=1}^{\infty} w_t^{(h)} = 1$) and Dur is a weighted average of cash flow maturities with weights depending on how important the given cash flow is to the current investment value. A low (or short) duration tells us that most of the investment value is due to short-term cash flows and the opposite is true for a high (or long) duration.

For U.S. treasury bonds, calculating duration is trivial since CF_{t+h} is known as of t so that dr is simply the (log) bond yield, which is also observable. For investments with risky cash flows, however, estimating $\mathbb{E}_t[CF_{t+h}]$ and dr is a challenge.

To define equity duration, I treat firms' payout (dividends + repurchases - issuances), PO, as cash flows to equity investors so that V is the firm's market equity, ME, and $w_t^{(h)} = (\mathbb{E}_t\left[PO_{t+h}\right] \cdot e^{-h \cdot dr_t})/ME_t$. Consequently, dr can be defined as the discount rate that satisfies $\sum_{h=1}^{\infty} w_t^{(h)} = 1$ or, equivalently, the dr that solves the valuation equation:

$$ME_t = \sum_{h=1}^{\infty} \mathbb{E}_t\left[PO_{t+h}\right] \cdot e^{-h \cdot dr_t} \tag{2}$$

Equations 1 and 2 together with $V = ME$ and $CF = PO$ provide the full definition of equity duration.[3]

b) Measurement

The entire challenge in measuring equity duration is on estimating $\mathbb{E}_t\left[PO_{t+h}\right]$. To do so, let clean surplus earnings be $CSE_t = PO_t + \Delta BE_t$, with BE representing book equity and Δ the difference operator. Then, substituting the CSE definition into $\mathbb{E}_t\left[PO_{t+h}\right]$ gives:

$$\begin{aligned}\frac{\mathbb{E}_t\left[PO_{t+h}\right]}{BE_t} &= \mathbb{E}_t\left[\left(1 + \frac{CSE_{t+h}}{BE_{t+h-1}} - \frac{BE_{t+h}}{BE_{t+h-1}}\right) \cdot \prod_{\tau=1}^{h-1} \frac{BE_{t+\tau}}{BE_{t+\tau-1}}\right] \\ &= \mathbb{E}_t\left[\left(e^{CSprof_{t+h} - BEg_{t+h}} - 1\right) \cdot e^{\sum_{\tau=1}^{h} BEg_{t+\tau}}\right]\end{aligned} \tag{3}$$

[3] In Section 4, I explore two alternative equity duration measures that do not require dr estimation and find results consistent with the ones obtained from my baseline equity duration measure.

where the second equality follows from the definitions $CSprof_t = ln\left(1 + CSE_t/BE_{t-1}\right)$ and $BEg_t = ln(BE_t/BE_{t-1})$.

To estimate $\mathbb{E}_t\left[PO_{t+h}\right]/BE_t$ at the firm-level, I follow Vuolteenaho (2002) and Campbell, Polk, and Vuolteenaho (2009) and assume s_t is a vector of firm-level characteristics (including a constant, $CSprof_t$, and BEg_t) that follows a Vector Autoregressive (VAR) system of order one:

$$s_t = \Gamma s_{t-1} + u_t \tag{4}$$

where $u_t \overset{i.i.d}{\sim} \mathcal{N}\left(0, \Sigma\right)$ with arbitrary cross-sectional covariance structure.

Using the VAR system in Equation 4, we have (see Internet Appendix A for details):

$$\frac{\mathbb{E}_t\left[PO_{t+h}\right]}{BE_t} = \left[e^{(\mathbf{1}_{CSprof}-\mathbf{1}_{BEg})'\Gamma^h s_t + v_1(h)} - 1\right] \cdot e^{\mathbf{1}'_{BEg}\left(\sum_{\tau=1}^{h}\Gamma^{\tau}\right)\cdot s_t + h\cdot v_2(h)} \tag{5}$$

where $\mathbf{1}_x$ is a selector vector such that $\mathbf{1}'_x s_t = x_t$ and $v_i(h)$ are parameters that depend on Γ, Σ, and h, but not on the state vector and so they provide no relevant cross-sectional variation in duration.

Substituting Equation 5 into 2, we can find the firm discount rate as the dr that solves:

$$ME_t/BE_t = \sum_{h=1}^{\infty}\left[e^{(\mathbf{1}_{CSprof}-\mathbf{1}_{BEg})'\Gamma^h s_t + v_1(h)} - 1\right] \cdot e^{\mathbf{1}'_{BEg}\left(\sum_{\tau=1}^{h}\Gamma^{\tau}\right)\cdot s_t - h\cdot dr_t + h\cdot v_2(h)} \tag{6}$$

and calculate duration by rewriting Equation 1 as:

$$Dur_t = (BE_t/ME_t)\cdot\sum_{h=1}^{\infty} h\cdot\left[e^{(\mathbf{1}_{CSprof}-\mathbf{1}_{BEg})'\Gamma^h s_t + v_1(h)} - 1\right] \cdot e^{\mathbf{1}'_{BEg}\left(\sum_{\tau=1}^{h}\Gamma^{\tau}\right)\cdot s_t + h\cdot v_2(h) - h\cdot dr_t} \tag{7}$$

I use a root-finding algorithm for each firm/year separately on Equation 6 to solve for dr_t given s_t and the VAR parameter estimates for Γ and Σ. I then use Equation 7 to calculate duration for the given firm/year. As a consequence, Dur_t is an implicit function of s_t and the VAR parameter estimates.

I estimate the VAR parameters on an expanding window such that Dur_t only requires information that is publicly available by time t. The next subsection provides the empirical details on how I estimate the VAR parameters and construct portfolios sorted on equity duration.

1.2 Sample Construction

a) Data

Stock return data come from the Center for Research in Security Prices (CRSP) monthly stock file and accounting data from COMPUSTAT annual file.[4] I follow the literature and restrict my analysis to common stocks of firms incorporated in the United States (shrcd = 10 or 11) trading on NYSE, Amex, or Nasdaq (exchcd = 1,2 or 3). I exclude utilities (4900≤SIC≤4949) and financials (6000≤SIC≤6999) and require a minimum of two previous years in COMPUSTAT for a company to be included in my analysis with the objective of alleviating backfilling concerns (see Fama and French (1993)).

To estimate equity duration, I form s_t based on twelve state variable split among four broad categories:

(i) Valuation Measures:

- book-to-market: $bm_t = ln\,(BE_t/ME_t)$;
- payout yield: $POy_t = ln\,(1 + PO_t/ME_t)$;
- sales yield: $Yy_t = ln\,(Y_t/ME_t)$;

(ii) Growth Measures:

- book-equity growth: $BEg_t = ln\,(BE_t/BE_{t-1})$;
- asset growth: $Ag_t = ln\,(A_t/A_{t-1})$;
- sales growth: $Yg_t = ln\,(Y_t/Y_{t-1})$;

[4] I account for delistings when calculating stock returns. I use CRSP delisting data to calculate delisting returns whenever possible and when a delisting return cannot be calculated I assume a -30% return for delisting by cause (400≤ dlstcd ≤599) based on the findings of Shumway (1997) and a 0% return for other cases. I pro-rate delisting returns over the period from the last available price to the month of the delisting price as in Cohen, Polk, and Vuolteenaho (2009).

(iii) Profitability Measures:[5]

- clean-surplus profitability: $CSprof_t = ln\left(1 + \frac{PO_t + \Delta BE_t}{BE_{t-1}}\right)$;
- return-on-equity: $Roe_t = ln\left(1 + \frac{E_t}{0.5BE_t + 0.5BE_{t-1}}\right)$;
- gross profitability: $Gprof_t = ln\left(1 + \frac{GP_t}{0.5A_t + 0.5A_{t-1}}\right)$;

(iv) Capital Structure Measures:

- market-leverage: $Mlev_{j,t} = B_t / \left(ME_t + B_t\right)$;
- book-leverage: $Blev_{j,t} = B_t / A_t$;
- cash-holdings: $Cash_{j,t} = C_t / A_t$.

where ME is market-equity from CRSP and all other variables are constructed from COMPUSTAT. BE is book equity following Davis, Fama, and French (2000); A is total assets (at); Y is total revenue ($revt$); PO is net payout following Boudoukh et al. (2007);[6] E is income before extraordinary items (ib); GP is gross profits ($revt - cogs$) following Novy-Marx (2013); B is total book debt ($dltt + dlc$ as long as one of the two is available); and C is cash

[5] For the denominator of return-on-equity (gross profitability) I use the average of initial and final book equity (total assets) over the fiscal period. This is a compromise between the two typical approaches of using either beginning of period (e.g., Hou, Xue, and Zhang (2015)) or end of period (e.g., Novy-Marx (2013) and Fama and French (2015)) book-equity/total assets to measure profitability. Profits are generated over the fiscal year so that neither the beginning nor the end of the period represents the basis for the profit generation, and thus I take the average between them. The definition of $CSprof$ in the calculation of duration does not allow me to use this approach for clean-surplus profitability, which requires beginning of period book equity.

[6] To define net payouts, PO, I start by defining book value of preferred stock ($BVPS$), which is given by redemption ($pstkrv$), liquidation ($pstkl$), or par value ($pstk$) of preferred stock in this order. Then, the net payout in any given fiscal year is equal to cash dividends (dvc) + net equity repurchases, which is given by the total expenditure on the purchase of common and preferred stocks ($prstkc_t$) - sale of common and preferred stock ($sstk$) + net issuances of preferred stocks ($BVPS_t - BVPS_{t-1}$). The COMPUSTAT data required to calculate net equity repurchases is only available starting in 1971. As such, for the earlier period, which is only used for the VAR estimation, I also follow Boudoukh et al. (2007) and use CRSP data: $PO = R_t \cdot ME_{t-1} - ME_t$.

and short-term investments (*che*).[7] All raw level quantities are deflated by the CPI index before calculating ratios.

From equation 7, the state variables only matter for the duration calculation to the extent that they predict $CSprof$ or BEg at some horizon. Since these variables are the only source of cross-sectional variation in duration in my framework, twelve state variables is a reasonable compromise between parsimony and achieving cross-sectional variability in duration.

b) Portfolios Sorted on Equity Duration

At June of year t (with t from 1973 to 2016) I form ten (value-weighted and equal-weighted) decile portfolios by sorting stocks based on their Dur_t and study the returns on these portfolios over the subsequent twelve months (so that portfolio returns go from July/1973 to June/2017). For value-weighted portfolios, I use NYSE breakpoints to define thresholds to assign stocks into portfolios, but form portfolios with all stocks in the sample (as in Fama and French (1993)). For equal-weighted portfolios, I follow Hou, Xue, and Zhang (2019) and completely exclude microcaps (defined as the firms below the 20% quantile of market equity based on NYSE breakpoints) to make sure results are not due to these firms. I then define breakpoints and form decile portfolios with the remaining firms. For both value- and equal-weighted portfolios, I hold each stock for one year and repeat the procedure the following June (equal-weighted portfolios are rebalanced every month to keep equal weights for each stock). After stock delistings, I rebalance the portfolios to keep value- or equal-weighted returns across the available stocks.

Dur_t in June of year t is estimated from equation 7 with dr_t implied by the valuation equation 6 given the state vector, s_t. Accounting information used to construct the state

[7] I impose some minor screenings in the data used to get the state vector, s_t. I set any non-positive A, BE, ME, and Y to missing as well as any negative C, B, and cash dividends. I also set to missing any BE, C, and B higher than A. Similar to Vuolteenaho (2002), I set to missing any BE higher than $50 \times ME$ or below $(1/50) \times ME$ and set any profitability ratio to -99% when below this value so that the log transformation is always feasible and firms do not lose more than 100% their book equity (or assets). Finally, to avoid the effect of outliers, I winsorize each non-bounded variable in the state vector at 1% and 99% percentiles for each cross-section (this avoids any look-ahead bias in the winsorization).

vector is from the fiscal year ending in calendar year $t-1$ and market-equity as of December of $t-1$ (same time convention as Fama and French (1992)).

Dur_t also depends on VAR parameters, which are estimated using an expanding window such that estimates used in June of year t rely on information no later than December of calendar year $t-1$. The first use of Dur_t to create equity duration portfolios is in 1973, which gives ten years of data (1963-1972) for my initial estimation of the VAR parameters as I do not rely on COMPUSTAT data before 1963.

I use the same Γ and Σ for all firms so that all cross-sectional variability in duration comes from the state vector, s_t. I estimate the autoregressive matrix, Γ, equation by equation from Fama-MacBeth regressions and the covariance matrix, Σ, based on the sample analogue constructed from pooling observations of firm-demeaned residuals. To minimize the effect of small stocks on the VAR parameters, I always exclude microcaps (firms below the 20% quantile of market equity based on NYSE breakpoints) when estimating Γ and Σ even when microcaps are included in the portfolios. The intercepts in the Γ matrix define the long-term behavior of $\mathbb{E}[CSProf]$ and $\mathbb{E}[BEg]$ and have no cross-sectional variability given the use of a common Γ across firms. To minimize the effect of extreme observations on the long-term expected profitability and growth, I select the intercepts to match the time-series average of cross-sectional medians for each of the variables in the state vector (using the same expanding window as for other parameters in Γ).

2 Portfolios Sorted on Equity Duration

In this section, I study the basic properties of the short duration premium. Subsection 2.1 reports summary statistics on the sample I use to construct the duration portfolios, subsection 2.2 validates the equity duration measure I rely on, subsection 2.3 demonstrates the short duration premium is (economically and statistically) significant, long-lived, and strong even among the largest firms, and subsection 2.4 shows that the value and profitability premia disappear after controlling for duration.

2.1 Summary Statistics for Stocks in Duration Portfolios

Table 1 summarizes the sample of firms used to construct the duration portfolios (Panel A) as well as the characteristics of firms in each portfolio (Panel B).[8]

The first two columns of Panel A demonstrate that the sample is comprehensive despite requiring the availability of the full state vector, s_t. Specifically, the average number of firms available in a given year is 2,580, which, on average, accounts for 88.1% of the market equity available in an analogous sample that requires only ME and BE to be non-missing. The other columns show the year by year cross-sectional distribution of some of the key variables in my analysis: duration (Dur), book-to-market (BM), book equity growth (BEg), and clean surplus profitability ($CSprof$).

There is substantial variability in duration, which is important since my goal is to form portfolios that are as distinct as possible on this dimension. The time-series average of the median firm duration is 40.7 years, with the 10% and 90% quantiles being 17.9 and 99.6 years respectively. This equity duration distribution is reasonable as it implies plausible variation in average dividend yields in the context of a simple log-linear approximation. Specifically, Campbell and Shiller (1989)'s log-linear approximation implies $Dur \approx 1 + e^{-\overline{dp}}$, where dp is the firm log dividend yield.[9] The average $\overline{dp}$ obtained by aggregating firm-level information in my sample yields $Dur \approx 48.1$ years. The same exercise implies $Dur \approx 38.4$ years if we replace dividends with net payout. Moreover, a stock with relatively high average dividend yield (of 6%) would have a low equity duration of 17.67 years and a stock with relatively low dividend yield (of 1%) would have a high equity duration of 101 years.

Panel B displays the time-series averages of portfolio level characteristics (value-weighted across firms). The short duration decile tends to be composed of small, value, and profitable companies. The opposite is true for the long-duration decile. I further explore the relation

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[8] For completeness, rank correlations between firm-level characteristics are also provided in Internet Appendix Table IA.1.

[9] Replacing all expected returns by the same discount rate, dr_t, in Campbell and Shiller (1989)'s log-linear approximation to stock prices yields: $p_t = constant + d_t + \sum_{h=1}^{h=\infty} \rho^{h-1}(\mathbb{E}_t[\Delta d_{t+h}] - dr_t)$. Then, duration is given by $-\partial p_t/\partial dr_t = \sum_{h=1}^{h=\infty} \rho^{h-1} = 1/(1-\rho) = 1 + e^{-\overline{dp}}$, with the last equality using $\rho = 1/(1 + e^{\overline{dp}})$.

between duration, valuation, growth, and profitability in Subsection 2.4.

2.2 Validating Duration Portfolios

Figure 1 validates the duration portfolios I construct by demonstrating that (i) shorter duration stocks pay a larger fraction of their market equity over the short horizon (1 to 10 years) and (ii) longer duration stocks are more exposed to movements in the dividend term structure as defined by the return differential between the equity index and its short-term dividend claim (see Binsbergen and Koijen (2017) for a discussion).

Figure 1(a) shows the cumulative fraction of market equity that firms in each duration decile pay (in net payouts) over the ten years following the duration measurement. Figure 1(b) repeats this analysis after replacing net payouts with cash dividends.[10] Focusing on net payouts, firms in the short duration portfolio tend to pay, on average, about 35% of their market equity over the first ten years after duration is measured. The same figure is close to 15% for firms in the long duration portfolio. The evidence indicates that firms classified as short duration equity indeed have a larger fraction of firm value associated with short term cash flows in comparison to long duration firms.

Figures 1(c) and 1(d) show the regression slopes of duration portfolio returns on the dividend term structure, measured as returns on a long-short portfolio that buys a long-duration asset (an equity index) and sells a short-duration asset (a short-term dividend claim). Figure 1(c) uses returns on the S&P500 as the long-duration asset and returns on a S&P500 dividend claim (with maturity between 1 and 2 years) as the short duration asset.[11]

[10]Specifically, for portfolios formed in June of year $t+1$, I start by restricting the sample to firms with fiscal year end in December of year t to align all accounting information. Then, I measure the total market equity as of December of year t for each portfolio as well as the total net payout (and cash dividends) paid in years $t+1$, $t+2$, ..., $t+10$ (with fixed portfolio composition). The fraction of ME paid in year $t+\tau$ is $\sum_{j=1}^{N_{t+\tau}} PO_{j,t+\tau}/\sum_{j=1}^{N_{t+\tau}} ME_{j,t}$ and I sum these values for $1 \leq \tau \leq h$ to obtain the fraction of ME paid within h years (with analogous procedure for cash dividends). The graphs report the time average of these fractions for each portfolio for $h = 1, 2, ..., 10$.

[11]To avoid potential illiquidity/microstructure issues, I follow the recommendation in Boguth et al. (2012) and use annual log returns for the long-short strategy (and rely on annual log excess returns on the duration portfolios to measure betas). Annual returns on the S&P500 dividend claim go from June of 1997 to June of 2017 (see Internet Appendix B for a detailed description of its construction).

Figure 1(d) provides results using (shocks to) annual log returns on the CRSP equity portfolio as the long-duration asset and (shocks to) annual log dividend growth on the same portfolio as the short-duration asset.[12] This alternative approach captures the dividend term structure because (shocks to) annual returns on a 1-year dividend claim, $R_{d,t}^{(1)} = D_t/P_{t-1}^{(1)}$, are equal to (shocks to) annual log dividend growth: $log(R_{d,t}^{(1)}) - \mathbb{E}_{t-1}[log(R_{d,t}^{(1)})] = \Delta d_t - \mathbb{E}_{t-1}[\Delta d_t]$.

Consistent with the idea that cash flow duration increases from the first to the tenth duration decile, the exposure of duration portfolios to the dividend term structure tends to increase as we move from decile one to decile ten. This is true regardless of whether we focus on value- or equal-weighted portfolios. The overall evidence indicates that my equity duration measure indeed captures equity cash flow duration.

2.3 The Short Duration Premium

Table 2 shows the existence of a short duration premium; a strategy that buys the short duration decile and sells the long duration decile has positive average returns from July of 1973 to June of 2017. Moreover, the premium (i) lasts for at least five years; (ii) is large even among the largest U.S. firms; (iii) delivers a substantial Sharpe Ratio; and (iv) remains strong (as α) after accounting for exposure to standard risk factors in the literature.

Panel A focuses on (annualized) average excess returns and Sharpe Ratios. I focus the discussion on value-weighted returns (first half of the panel), but results are slightly stronger for equal-weighted returns (second half of the panel). Column $\overline{r}_{t\rightarrow t+1}$ shows a short duration premium of 9.2% on an annual basis ($t_{stat} = 3.79$). Moreover, the decline in average excess returns from decile one to decile ten is almost monotonic and a similar pattern is observed in Sharpe Ratios (Column $\overline{r}/\sigma$). Column $\overline{r}_{t\rightarrow t+5}$ shows the general declining pattern in average returns from short to long duration stocks is also true if the portfolio holding period is five years, with an annual premium of 7.1% ($t_{stat} = 3.97$). Based on column $\overline{r}_{t+4\rightarrow t+5}$, even if we

[12] Shocks are measured as residuals on annual predictive regressions in which the predictive variables are the ones in the state vector described in the next section, but results are not sensitive to changing this specification. For instance, using only dividend yield as a predictive variable delivers very similar results. Further details on the the measurement of returns, dividend growth, and the state variables are provided in the next section.

use duration estimated four years before the sorting date, we still observe a short duration premium of 3.0%, although the premium is statistically weaker in this case ($t_{stat} = 1.46$). Finally, column $\overline{r}^{Large}_{t \to t+1}$ shows the premium is still significant (7.2% with $t_{stat} = 2.55$) when only large firms are used to construct portfolios (defined as the firms above the 80% quantile of market equity based on NYSE breakpoints).

Panel B presents the results of factor regressions. The first two columns show that the short duration premium is even larger when stated in terms of annualized CAPM αs (10.5% with $t_{stat} = 3.94$) since market betas increase in equity duration. The next set of columns show that the extra risk factors in the Fama and French (2015)'s 5-Factor model partially explain this premium, but the β patterns are relatively weak, non-monotonic, and still leave an α of 5.1% ($t_{stat} = 2.91$), more than half the raw short duration premium. The last set of columns show relatively similar results using Hou, Xue, and Zhang (2015)'s q-Factor model. The α is still 6.8% ($t_{stat} = 3.08$) with betas on the size and investment factors helping to reduce the short duration premium slightly.

Figure 2 reports the short duration premium (value- and equal-weighted) on a 20-year rolling window to demonstrate that it is not concentrated in any particular period. Clearly, the short duration premium is positive for any 20-year window one selects. The figure also plots the 95% confidence interval. There are periods in which we cannot reject that the premium is zero, but this is a consequence of the higher standard errors associated with a shorter sample. Even in these periods, the estimated premium is above 5%, which is substantial if we consider that these are the 20-year periods with the weakest short duration premia in the sample.

2.4 Equity Duration, Value, and Profitability

I now explore the interaction between duration and the four firm-level characteristics that have been included in recent factor models (e.g., Fama and French (2015) and Hou, Xue, and Zhang (2015)) as important determinants of expected returns: value, profitability, asset growth, and size.[13] The key result is that the value and profitability premia disappear after controlling for duration.

Simultaneously controlling for multiple firm-level characteristics in asset pricing tests is challenging. As Cochrane (2011) states, "...we will have to use different methods. Portfolio sorts are really the same thing as nonparametric cross-sectional regressions...But we cannot chop portfolios 27 ways, so I think we will end up running multivariate regressions...Running multiple panel-data forecasting regressions is full of pitfalls of course. One can end up focusing on tiny firms, or outliers. One can get the functional form wrong...we must address the factor zoo, and I do not see how to do it by a high-dimensional portfolio sort".

Since my goal is to study the effect of duration, value, and profitability jointly, I design a simple method to compare multiple characteristics in the context of panel regressions while still relying on portfolio sorts to address Cochrane (2011)'s concerns with stock-level panel regressions. Specifically, I estimate panel regressions using portfolio returns on the left side and the average decile values as covariates. Consider the case in which only duration and value are studied. I form 10 decile portfolios for duration and 10 for value and assign each stock a duration decile number as well as the value decile number (i.e., I create value decile and duration decile as firm-level characteristics). Then, for each duration portfolio, I calculate the average value decile of its stocks and similarly for value portfolios. At the end of this procedure, I have 20 decile portfolios with each portfolio having an average duration decile as well as an average value decile. I then regress portfolio returns on portfolio deciles, which is a multivariate version of the typical average High-Low returns.[14]

[13]Following Fama and French (1992), I use book-to-market to proxy for value and market equity to proxy for size. My asset growth measurement is consistent with Fama and French (2015) and Hou, Xue, and Zhang (2015) and I proxy for profitability using the gross profitability measure in Novy-Marx (2013) as he finds that gross profitability performs better than many other profitability variables in predicting the cross-section of stock returns. To be consistent with Novy-Marx (2013), I use current assets as the denominator of gross profitability as opposed to $0.5 \cdot A_{t-1} + 0.5 \cdot A_t$ (used in the VAR to account for the fact that profits are generated over the fiscal year period). I still refer to the gross profitability measure as $Gprof$ and the results are very similar if the measurement is set to be consistent with the VAR estimation.

[14]Specifically, with only one covariate (e.g., only 10 duration deciles) the OLS estimate, $\widehat{b}$, of this pooled panel regression is given by $9 \cdot \widehat{b} = \sum_{i=0}^{4} w_i \cdot (\overline{R}_{10-i} - \overline{R}_{1+i}) \cdot \frac{9}{9-2\cdot i}$, where $w_i = (4.5-i)^2 / \sum_{k=0}^{4} (4.5-k)^2$ are weights and $9 \cdot \widehat{b}$ provides an estimate for the High-Low portfolio predicted by the given regression model

Table 3 provides results from these panel regressions of returns on portfolio deciles. The description focuses on value-weighted portfolios, but equal-weighted results are similar. Columns [1.1] to [1.8] only include in the panel data the decile portfolios of characteristics accounted for in the respective regression specification. For instance, column 1.2 uses twenty deciles, ten from duration and ten from book-to-market. Columns [2.1] to [2.7] keep all fifty decile portfolios (for duration, value, asset growth, profitability, and size) irrespective of the regression specification.

Column 1.1 shows univariate regression results. The implied short duration premium is 9.1% ($t_{stat} = 4.09$) on an annual basis, which is very similar to the findings in Table 2. All other variables induce premia with the expected sign. Only the profitability premium is insignificant in value-weighted portfolios ($t_{stat} = 0.58$), but it is still significant when considering equal-weighted portfolios ($t_{stat} = 2.12$).

Columns 1.2 to 1.5 consider the premium associated with each variable after controlling for duration. For all variables other than duration the premium is reduced and becomes insignificant, with the exception that the the premium for low asset growth companies is reduced, but still significant in equal weighted portfolios ($t_{stat} = 2.60$). The value premium is substantially reduced after accounting for duration, changing from a significant 5.1% ($t_{stat} = 2.12$) to an insignificant 0.7% ($t_{stat} = 0.23$). Moreover, the point estimate for the profitability premium even becomes negative. In contrast to the unrobust value, profitability, asset growth, and size premia, the short duration premium tends to become stronger after controlling for other premia. For instance, after controlling for the profitability premium, the short duration premium becomes 12.7% ($t_{stat} = 4.48$).

One of the key messages in Novy-Marx (2013) is that the value and profitability premia

since there are nine decile increases between deciles one and ten. The predicted premium is a weighted average of several terms. The first term is the average return on the High-Low portfolio (when $i = 0$, we have $\overline{R}_{10} - \overline{R}_1$), which is the focus of the typical analysis. The second term, $(9/7) \cdot (\overline{R}_9 - \overline{R}_2)$, is the spread between the second set of most extreme portfolios scaled to have the same units as average return on the High-Low portfolio. All other terms are similar, with the last term being $9 \cdot (\overline{R}_6 - \overline{R}_5)$. Of course, not all long-short portfolios provide the same level of information, with the most extreme deciles being more important. The OLS weights the terms accordingly (trough w_i) to incorporate information from all decile spreads in the appropriate manner.

become substantially stronger after controlling for each other. Column 1.6 demonstrates this result. The value premium increases from 5.1% ($t_{stat} = 2.12$) to 12.6% ($t_{stat} = 3.29$) and the profitability premium increases from an insignificant 1.3% ($t_{stat} = 0.58$) to a significant 9.6% ($t_{stat} = 2.70$).

Interestingly, after controlling for duration, the value and profitability premia disappear despite also being controlled for each other. In fact, the point estimates for both premia even become negative in value-weighted portfolios. Specifically, the value premium decreases from 12.6% ($t_{stat} = 3.29$) to -1.5% ($t_{stat} = -0.28$) and the profitability premium decreases from 9.6% ($t_{stat} = 2.70$) to -2.5% ($t_{stat} = -0.52$). In contrast to the value and profitability premia, the short duration premia becomes very strong after controlling for both value and profitability (13.9% with $t_{stat} = 3.03$).

Finally, in a panel regression including all five variables, only the short duration premium is significant (15.8% with $t_{stat} = 2.62$) with the point estimates for the value and profitability premia remaining negative. Equal-weighted portfolios deliver similar qualitative results, except that the point estimates for the value and profitability premia are still positive (although small and insignificant) and the low asset growth premium is still significant (4.0% with $t_{stat} = 2.52$).

None of the qualitative results described in the previous paragraphs changes in columns 2.1 to 2.7, where all fifty decile portfolios are kept in the panel data irrespective of the regression specification (note that specification 2.8 is not necessary since it would be identical to 1.8). Moreover, Internet Appendix Table IA.2 shows the same results also hold in firm-level Fama-MacBeth regressions that directly use the firm characteristics as covariates.

The overall conclusion is that the profitability and value premia exist only as a consequence of the endogenous correlation between duration, value, and profitability. Intuitively, if two firms have different growth opportunities, but the same profitability, the one with less growth opportunities (the value firm) will save/invest less given the lack of growth opportunities. Consequently, value companies (controlling for profitability) tend to be short duration companies as they are expected to pay more of their resources to investors over the short term. Similarly, if two firms have different profitability, but similar growth opportunities, the more profitable one will have more resources to distribute to investors in the near future. Consequently, profitable companies (controlling for growth opportunities) also tend to be short duration firms.

3 Short Duration Premium and Reinvestment Risk

The empirical results in the previous section suggest that the short duration premium is an equilibrium outcome as opposed to an anomaly that concentrates in small stocks and quickly disappears. Moreover, the findings indicate that equity duration is linked to firm fundamentals and can help us better understand different phenomena in cross-sectional asset pricing. Consequently, it is important to understand what drives the short duration premium.

This section provides a novel explanation for why the short duration premium exists in financial markets. Subsection 3.1 builds on the ICAPM of Campbell (1993) to argue that long-term investors care about long-term wealth, and thus price market risk (i.e., variation in current wealth) as well as reinvestment risk (i.e., variation in expected wealth growth). Subsection 3.2 empirically demonstrates that investors can only earn the short duration premium by being exposed to substantial reinvestment risk and this exposure is enough to explain the short-duration premium observed empirically. Finally, Subsection 3.3 shows that the short duration premium is much larger in periods in which earning the premium requires higher exposure to reinvestment risk.

3.1 An Intertemporal CAPM with Reinvestment Risk

a) The Model

A long-term investor with relative risk aversion γ and initial wealth W_t chooses her portfolio allocation to maximize expected utility of wealth H years ahead, $\mathbb{E}_t\left[\frac{1}{1-\gamma}\cdot W_{t+H}^{1-\gamma}\right]$. She can invest in a baseline asset with gross real return $R_{f,t}$ as well as in a set of risky assets with gross real return vector R_t to form her wealth portfolio, $R_{w,t}$. Wealth evolves according to

$W_{t+1} = W_t \cdot R_{w,t+1}$ and the investor's allocation optimality conditions can be stated as (for any asset j):[15]

$$\mathbb{E}_{t-1}\left[R_{w,t}^{-\gamma} \cdot \left(\Pi_{h=1}^{H-1} R_{w,t+h}\right)^{-(\gamma-1)} \cdot (R_{j,t} - R_{f,t})\right] = 0 \tag{8}$$

Consequently, shocks to the long-term investor's log Stochastic Discount Factor (SDF) are given by:

$$\tilde{m}_t \;=\; -\;\gamma \cdot \tilde{r}_{w,t} \;-\; (\gamma - 1) \cdot N_{\mathbb{E}r,t}^{(H-1)} \tag{9}$$

so that the risk premium on any asset j relative to asset i can be written as:[16]

$$\mathbb{E}_{t-1}\left[R_{j,t} - R_{i,t}\right] = \gamma \cdot Cov_{t-1}\left(r_{j,t} - r_{i,t}, \tilde{r}_{w,t}\right) \;+\; (\gamma - 1) \cdot Cov_{t-1}\left(r_{j,t} - r_{i,t}, N_{\mathbb{E}r,t}^{(H-1)}\right) \tag{10}$$

$$\Downarrow$$

$$\mathbb{E}\left[R_{j,t} - R_{i,t}\right] = \gamma \cdot Cov\left(r_{j,t} - r_{i,t}, \tilde{r}_{w,t}\right) \;+\; (\gamma - 1) \cdot Cov\left(r_{j,t} - r_{i,t}, N_{\mathbb{E}r,t}^{(H-1)}\right) \tag{11}$$

Intuitively, the long-term investor cares about wealth H years ahead so that shocks to current wealth, $\tilde{r}_{w,t} = \widetilde{\Delta w_t}$, and news about expected wealth growth over the subsequent $H-1$ years, $N_{\mathbb{E}r,t}^{(H-1)} = (\mathbb{E}_t - \mathbb{E}_{t-1})\left[\Sigma_{h=1}^{H-1} r_{w,t+h}\right] = (\mathbb{E}_t - \mathbb{E}_{t-1})\left[\Sigma_{h=1}^{H-1} \Delta w_{t+1}\right]$, are both priced with $\tilde{r}_{w,t}$ capturing market risk and $N_{\mathbb{E}r,t}^{(H-1)}$ reinvestment risk.[17]

To complete the model, I follow the ICAPM literature and assume the wealth portfolio is equal to the equity market portfolio, $r_{w,t} = r_{e,t}$.[18] Following Binsbergen and Koijen (2010),

[15]Letting π_t represent the wealth portfolio weights, the objective function can be written as $\mathbb{E}_t[(\Pi_{h=2}^{H} R_{w,t+h})^{1-\gamma} \cdot (R_{f,t+1} + \pi_t^{'}(R_{t+1} - R_{f,t+1}))^{1-\gamma}]$ so that taking derivative with respect to $\pi_{j,t}$ yields Equation 8.

[16]As in Campbell et al. (2017), this equation requires either joint normality for r_j, r_i, and m or the usual 2nd order Taylor expansion for $E[e^{m_{t+1}+r_{j,t+1}}] = 1$. For notation convenience, I following Campbell et al. (2017) and also use the approximation $\mathbb{E}_t[r_{j,t+1} - r_{i,t+1}] + \frac{1}{2}(\sigma_{j,t}^2 - \sigma_{i,t}^2) \approx \mathbb{E}_t[R_{j,t+1} - R_{i,t+1}]$. Otherwise, all results can be understood from the perspective of the relative "log risk premia", $\mathbb{E}_t[r_{j,t+1} - r_{i,t+1}] + \frac{1}{2}(\sigma_{j,t}^2 - \sigma_{i,t}^2)$.

[17]The $\gamma > 1$ condition for $N_{\mathbb{E}r,t}^{(H-1)}$ to have a positive risk price is a consequence of two offsetting effects. An asset that comoves positively with reinvestment rates is desirable since it provides more capital to be invested when expected returns are high, allowing the investor to take advantage of the better investment opportunities. However, the asset also exposes investors to reinvestment risk. When $\gamma > 1$, the latter effect dominates so that the price of risk for news about expected returns is positive.

[18]In this case, the expected return on wealth can only vary in equilibrium if volatility or risk prices also vary to keep the long-term investor satisfied with a fixed equity position. I do not take a stand on the source of variation in expected returns since it does not affect the unconditional equation 11, which is the base for

I assume (demeaned) equity expected log returns follow an autoregressive process of order one, AR(1):

$$\mathbb{E}_t r \;= \phi_r \cdot \mathbb{E}_{t-1} r \;+\; \widetilde{\mathbb{E}}_t r \tag{12}$$

This specification is convenient because it implies risk prices are fully characterized by relative risk aversion, γ, the investor's horizon, H, and the expected return persistence, ϕ_r:

$$\mathbb{E}\left[R_{j,t} - R_{i,t}\right] \;= \gamma \cdot Cov\left(r_{j,t} - r_{i,t}, \tilde{r}_{e,t}\right) \;+\; \lambda_{\mathbb{E}r} \cdot Cov\left(r_{j,t} - r_{i,t}, \widetilde{\mathbb{E}}_t r\right) \tag{13}$$

where $\lambda_{\mathbb{E}r} = (\gamma - 1) \cdot (1 - \phi_r^{H-1})/(1 - \phi_r)$ so that the price of reinvestment risk increases with γ, H, and ϕ_r.

Importantly, the model nests the CAPM because $\lambda_{\mathbb{E}r} = 0$ if the investor has a one period horizon ($H = 1$) or log utility ($\gamma = 1$). The model also reduces to the CAPM if there is no variation in expected returns ($\widetilde{\mathbb{E}}_t r = 0$).

Similar to empirical tests of the CAPM, I keep the investment horizon, H, fixed over time. Despite this simplifying assumption, one can still view this framework as an equilibrium model (with a representative investor or limited stock market participation) in which the maximization of wealth over a given horizon represents a simplified way to model intertemporal choices of an infinitely lived agent.[19]

b) Measuring Risk Factors

To measure the risk factors, $\tilde{r}_{e,t} = r_{e,t} - (\bar{r}_e + \mathbb{E}_{t-1} r)$ and $\widetilde{\mathbb{E}}_t r \;=\; \mathbb{E}_t r - \phi_r \cdot \mathbb{E}_{t-1} r$, I need to estimate the expected return process. I assume (as in Binsbergen and Koijen (2010)) that (demeaned) expected log dividend growth is also an AR(1), $g_t \;=\; \phi_g \cdot g_{t-1} + \widetilde{g}_t$, so that the log dividend price ratio, dp, follows an ARMA(2,1) that provides identification for

my empirical analysis.

[19] For instance, in the ICAPM of Campbell (1993), risk premia is given by an expression identical to Equation 13 except that $\lambda_{\mathbb{E}r} = (\gamma - 1) \cdot \delta/(1 - \phi_r \cdot \delta)$, with δ representing a log-linearization constant. Moreover, if the intertemporal elasticity of substitution is 1, then δ is equal to the investor's time discount factor. As such, there is a direct mapping between H in the finite horizon model and the time discount factor in the infinite horizon model. Specifically, $\delta = (1 - \phi_r^{H-1})/(1 - \phi_r^H)$.

$max(\phi_r, \phi_g)$ and $min(\phi_r, \phi_g)$.[20] A maximum likelihood estimation of this ARMA(2,1) process yields $max(\phi_r, \phi_g) = 0.880$ and $min(\phi_r, \phi_g) = 0.238$. Adding the identifying assumption that expected returns are more persistent than expected dividend growth, which is supported by the evidence in Binsbergen and Koijen (2010), I obtain $\phi_r = 0.880$ and $\phi_g = 0.238$. These estimates, which are entirely based on the dynamics of the dividend price ratio, are close to the $\phi_r = 0.932$ and $\phi_g = 0.354$ in Binsbergen and Koijen (2010).

Given the ϕ_r estimate, I only need a proxy for $\mathbb{E}_t r$ to get the risk factors. Letting z_t represent demeaned aggregate state variables, I assume $\mathbb{E}_t r = b' z_t$ and estimate b by OLS.[21]

In term of data measurement, equity market returns and dividends are based on a value-weighted portfolio containing all common stocks available in the CRSP dataset. I use six state variables in z_t (all measured in natural log units): dividend yield (dp), equity payout yield (poy), one year Treasury yield (ty), term spread (TS), credit spread (CS) and value spread (VS).[22] All of these variables have been explored in the literature as important predictors equity returns.[23] Internet Appendix D provides results that exclude predictive variables one

[20]From Campbell and Shiller (1989), we have $dp_t - \overline{dp} = B_r \cdot \mathbb{E}_t r - B_g \cdot g_t$ if expected returns and dividend growth are AR(1) processes. As such, dp is the sum of two AR(1) processes with persistence parameters ϕ_r and ϕ_g, which implies dp is a ARMA(2,1) with autoregressive parameters $\rho_1 = \phi_r + \phi_g$ and $\rho_2 = -\phi_r \cdot \phi_g$, and a moving average parameter that depends on the covariance structure of shocks (see Granger and Morris (1976) and Lütkepohl (1984)). Solving for ϕ_r and ϕ_g yields a quadratic system with solution $max(\phi_r, \phi_g) = 0.5 \cdot max(\rho_1 \pm \sqrt{\rho_1^2 + 4 \cdot \rho_2})$ and $min(\phi_r, \phi_g) = 0.5 \cdot min(\rho_1 \pm \sqrt{\rho_1^2 + 4 \cdot \rho_2})$.

[21]The OLS estimation of $b' z_t$ does not use information on dividend growth predictability. However, Campbell-Shiller decomposition implies $B_r \cdot \mathbb{E}_t r = (dp_t - \overline{dp}) + B_g \cdot g_t$ where $B_g = 1/(1 - \rho \cdot \phi_g)$ and $B_r = 1/(1 - \rho \cdot \phi_r)$, and Chen and Zhao (2009) argue that it is important to account for both return and dividend growth predictability when estimating ICAPM risk factors. As such, Internet Appendix Section D also provides results (consistent with the ones in the main text) using an alternative $\mathbb{E}_t r$ measure that accounts for both dividend growth and return predictability. Specifically, I estimate $b_r' z_t$ and $b_g' z_t$ by projecting returns and dividend growth onto z_t (using OLS) and set $\mathbb{E}_t r$ to the average of $b_r' z_t$ and $[(dp_t - \overline{dp}) + B_g \cdot b_g' z_t]/B_r$.

[22]The dividend yield is the log of aggregate dividends over a normalized index price. The equity payout yield is the log of (one plus) aggregate net equity payout over market equity. The term spread is the difference between the 10-year and 1-year log Treasury yields. The credit spread is the difference between Moody's corporate BAA and AAA log yields. Following Campbell and Vuolteenaho (2004), the value spread is the difference between the log book-to-market ratios of the value and growth portfolios formed based on small stocks with an adjustment to account for within year movements in market equity.

[23]Several papers use the dividend yield as a predictor for both dividend growth and stock returns, with theoretical justification provided by the valuation identity of Campbell and Shiller (1989). Modifications to this valuation identity can be used to motivate many additional valuation ratios as predictors for all three relevant variables. Following Boudoukh et al. (2007) and Larrain and Yogo (2008), I use the equity

at a time to demonstrate the robustness of the results to the specific state variables used.

The dividend measurement used is based on the sum of annual dividends with no compounding to avoid introducing properties of returns into dividend growth (see Chen (2009) and Binsbergen and Koijen (2010)) and includes M&A paid in cash (as suggested by Allen and Michaely (2003)). Both aspects serve to make the dividend price ratio, which is an important state variable in my analysis, more stationary (consistent with Koijen and Nieuwerburgh (2011) and Sabbatucci (2015)).[24]

Flow variables (such as dividend growth and returns) are deflated using the CPI index. Moreover, to avoid seasonality issues, I use monthly observations of annual flows. The final dataset used to estimate the risk factors is a multivariate time series of monthly observations in which flow variables have annual measurement; this dataset extends from Dec-1952 to Dec-2017.[25] In the Internet Appendix, I provide a more detailed description of the data sources/measurement (Section B) and also report the correlations between shocks to risk factors and state variables (Table IA.3).

3.2 Results from ICAPM Estimation

I estimate the ICAPM to demonstrate that reinvestment risk is an empirically credible explanation for the existence of a short duration premium.

a) Risk Exposures of Duration Portfolios

Table 4 provides the risk exposures of duration portfolios. The shocks and risk factors have annual measurement, so I compound the returns of duration portfolios from July of year t

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payout yield. The treasury yield (Fama and Schwert (1977) and Fama (1981)), term spread (Campbell (1987) and Fama and French (1989)), and credit spread (Keim and Stambaugh (1986)) are classical interest rate and equity return predictors. Finally, Campbell and Vuolteenaho (2004), Campbell, Polk, and Vuolteenaho (2009), and Campbell et al. (2017) rely on the value spread as an important predictor of stock returns.

[24]Internet Appendices B and D further discuss these adjustments and provide similar results after measuring dividends without accounting for M&A activity.

[25]The starting date is selected to strike a balance between a long sample period and consistency in the behavior of the state variables. In particular, the sample is based on the post-war period and starts after the Fed-Treasury Accord of 1951 that restored independence to the Fed, affecting monetary policy.

to June of year $t+1$ to match with annual risk factors when calculating betas. Moreover, all betas in this section come from log excess returns to match the ICAPM pricing equation 13. I focus on value-weighted portfolios in my description.

Column $\overline{r}$ shows average excess returns calculated directly from annual returns, with results being very similar to the ones presented in Table 2 (short duration premium of 9.5% with $t_{stat} = 3.28$). Columns β_m and $\beta_{\mathbb{E}r}$ display the risk exposures relevant to the ICAPM pricing equation. Market betas strongly increase in equity duration ($\beta_{10-1} = 0.52$ with $t_{stat} = 4.92$) while reinvestment risk strongly decreases in equity duration ($\beta_{10-1} = -1.85$ with $t_{stat} = -8.02$). Columns β_{dp} and β_{poy} show that the same reinvestment risk effect is observed if we proxy for shocks to expected returns using shocks to the dividend yield or the net payout yield, which is a common practice in the return predictability literature.[26]

Intuitively, decreases in expected returns are associated with increases in cash flow present values through lower discount rates, and this effect is stronger for the present value of longer term cash flows. As such $\beta_{\mathbb{E}r}$ decreases (becomes more negative) as equity duration increases. A simple way to understand this effect is to note that $Dur_t = -(\partial ME_t/\partial dr_t)/ME_t$, and thus equity duration reflects the proportional increase in firm value when the firm specific discount rate decreases. If discount rates comove positively, then long duration firms will tend to go up in value by more than short duration firms when market expected returns decline.

Column $\beta_{\Delta d}$ shows the exposure of duration portfolios to shocks in the aggregate dividend growth, $\Delta d_t - b_g' s_{t-1}$ (with b_g estimated by OLS). There is a (statistically weak) decreasing pattern in dividend growth risk exposure ($\beta_{10-1} = -0.27$ with $t_{stat} = -1.35$), which is consistent with the prominent explanation for the short duration premium provided in Lettau and Wachter (2007, 2011). I later demonstrate that the time-variation in the short duration premium is consistent with the reinvestment risk channel, but inconsistent with this alternative risk-based explanation.

[26]Table 2 uses residuals of AR(1) processes to proxy for shocks to dp and poy. However, very similar results are obtained from other specifications, such as using residuals of a projection of dp_{t+1} and poy_{t+1} onto z_t.

b) ICAPM Risk Prices and Pricing Errors

While risk exposures are informative, combining them to study ICAPM-implied risk premia requires properly estimating risk prices, which is done in Table 5 based on the pricing equation 13. Panel A uses (value- and equal-weighted) equity duration portfolio spreads ($R^{(h)}_{Dur} - R^{(1)}_{Dur}$) as testing assets so that the slope of the equity term structure is the key "moment" the model attempts to match. Panel B also requires the model to perfectly match the equity premium so that the level of the equity term structure is also matched.

The first specification, labeled CAPM, imposes $\gamma \geq 0$ and $\lambda_{\mathbb{E}r} = 0$ (i.e., $H = 1$) to reflect only market risk in the pricing equation. The second specification, labeled ICAPM, imposes $\gamma \geq 0$ and $0 \leq \lambda_{\mathbb{E}r}/(\gamma - 1) \leq (1 - \phi^{49})/(1 - \phi)$ (i.e., $1 \leq H \leq 50$) to reflect the ICAPM pricing equation with a wide range of potential investment horizons. The last specification, labeled ICAPM$_{\text{U}}$, imposes no restriction on $\lambda_m = \gamma$ and $\lambda_{\mathbb{E}r}$.[27] I focus on alphas of value-weighted portfolios in my description, but the alphas of equal-weighted portfolios are similar.

The CAPM clearly cannot capture the short duration premium. Since market betas increase in equity duration, $\gamma = 0$ when the estimation attempts to match only the slope of the equity term structure, leaving a large alpha for the short-duration premium ($\alpha_{10-1} = -9.5\%$ with $t_{stat} = -3.18$). When required to match the equity premium of 7.1%, the CAPM estimation yields $\gamma = 3.6$ and produces an even larger short-duration premium alpha ($\alpha_{10-1} = -13.6\%$ with $t_{stat} = -4.55$).

In contrast to the CAPM, the ICAPM performs well in capturing the short duration premium. Specifically, the short duration premium alpha is -2.0% ($t_{stat} = -0.67$) when the estimation attempts to match only the slope of the equity term structure and -3.0% ($t_{stat} = -1.00$) when the equity premium is also imposed. The main difference between the two specifications is that risk aversion increases from 6.4 ($t_{stat} = 2.40$) to 10.6 ($t_{stat} = 3.98$)

[27] All specifications are estimated using a pooled panel regression of returns on covariances while imposing the relevant equality and inequality restrictions. Standard errors are obtained using the Fama and MacBeth (1973) procedure. This entire estimation approach would be equivalent to Fama and MacBeth (1973) cross-sectional regressions of returns on covariances if there were no coefficient restrictions. A detailed description of the model estimation and inference is provided in Internet Appendix C.

once we require the ICAPM to reproduce the equity premium. These results indicate that a moderate risk aversion is enough to produce the short duration premium, but capturing the equity and short-duration premia jointly yields a relatively high risk aversion estimate (similar to the value used in the long-run risks literature). In terms of investor's horizon, ICAPM estimates imply a horizon of four years or infinite horizon with an annual time discount factor of 0.80 (see footnote 19). Interestingly, none of the ICAPM results change as we drop the model inequality restrictions on risk prices.

Figure 3 provides a graphical illustration of the ICAPM alphas (for the estimation that imposes the equity premium). While average excess returns strongly decrease in equity duration, ICAPM αs display no pattern in value- or equal-weighted portfolios (Figures 3(a) and 3(b)). Interestingly, despite the ICAPM estimation not using bond information, the model also goes a long way in capturing the fact that long duration (government and corporate) bonds have higher risk premia than short duration bonds (Figures 3(a) and 3(b)).

These results demonstrate that the reinvestment risk mechanism captures the short duration premium in equities without producing a (counterfactual) short duration premium in bonds. In contrast to stocks, bond prices decrease when expected returns declines because nominal interest rates are negatively correlated with equity expected returns (Fama and Schwert (1977), Campbell (1987), Ferson (1989), Shanken (1990), Brennan (1997), and Cederburg (2019)). Given their higher duration, longer-term bonds are more exposed to this risk, and thus command higher risk premia.

Overall, the findings in this subsection indicate that longer-duration stocks are better hedges for reinvestment risk and this effect is strong enough to induce a short duration premium of the magnitude observed in the data. Moreover, the same mechanism produces empirically credible bond risk premia, indicating that a unique channel is able to unify seemly opposite term structure patterns observed in equities and bonds.

3.3 Time-Varying Reinvestment Risk and Short Duration Premium

I now study the time variation in the reinvestment risk exposure of duration portfolios and its consequences for the short duration premium. I find that the short duration premium is substantially larger when earning the premium requires higher reinvestment risk exposure.

Equity duration, $Dur_t = -(\partial ME_t/\partial dr_t)/ME_t$, reflects the proportional increase in firm value when the firm specific discount rate decreases. As such, Dur directly reflects reinvestment risk exposure if there is a factor structure in discount rates. This connection suggests we should expect larger differences in reinvestment risk exposure across duration deciles when there is more cross-sectional variability in Dur_t. Therefore, taking the short duration strategy during these periods requires more reinvestment risk exposure which should induce a higher short duration premium under the ICAPM (holding everything else fixed).

To test this prediction, I start by constructing a measure of the cross-sectional variability in duration, labeled $\sigma(Dur)$. Specifically, for each year t, I select all firms with fiscal year ending in December and measure the standard deviation of $ln(Dur_t)$ at that point in time. The December fiscal year is imposed to align all accounting information used to construct $\sigma(Dur)$ and the logarithm transformation is used to decrease the large asymmetry in duration and the potential influence of outliers.[28]

Table 6 shows results (short duration premium and risk exposures) separately for periods of low $\sigma(Dur)$ (lower 25% observations), moderate $\sigma(Dur)$, and high $\sigma(Dur)$ (highest 25% observations). Taking the low $\sigma(Dur)$ period as an example, I select the years (t) with the 25% lowest $\sigma(Dur)$, collect returns and risk factors from July of year $t+1$ to June of year $t+2$ (same time convention as the portfolio formation), and calculate average returns and covariances based on this subset of years. I provide t-statistics for the tests comparing the low $\sigma(Dur)$ period with the respective (moderate or high) $\sigma(Dur)$ period. I focus the discussion on value-weighted returns and point out when there are relevant differences relative to equal-weighted returns.

[28]Internet Appendix Figure IA.1 displays $\sigma(Dur)$ from 1972 to 2015 (years linked to the portfolios constructed from June 1973 to June 2016).

Column $\overline{r}_e$ reports average excess returns for the aggregate equity market and find that the equity premium is similar for all three $\sigma(Dur)$ states. As such, the level of the equity term structure does not seem to vary with $\sigma(Dur)$. In contrast, as predicted by the link between $\sigma(Dur)$ and cross-sectional variation in reinvestment risk, $\sigma(Dur)$ is a strong predictor of the short duration premium. The premium is 4.8% following low $\sigma(Dur)$ periods and 20.8% following high $\sigma(Dur)$ periods ($t_{stat} = 2.29$ for the difference between the two periods).

The short duration strategy $\beta_{\mathbb{E}r}$ strongly varies with $\sigma(Dur)$ in a way consistent with the variation in the short duration premium. Specifically, $\beta_{\mathbb{E}r} = -1.01$ during periods of low $\sigma(Dur)$ and $\beta_{\mathbb{E}r} = -2.55$ during periods of high $\sigma(Dur)$. Despite the large shift in $\beta_{\mathbb{E}r}$, the difference in $\beta_{\mathbb{E}r}$ across low and high $\sigma(Dur)$ periods is only significant in equal-weighted portfolios.

Fully testing the ICAPM in a conditional fashion is out of the scope of this paper as it requires taking a stand on how volatility and risk prices vary over time (and imposing consistency between such variation and the expected return shocks). However, the overall results suggest that the variation in reinvestment risk is consistent with the variation in the short duration premium. Alternative explanation need to justify the large variation in the short duration premium across periods of low and high $\sigma(Dur)$, which is not trivial. For instance, explanations based on the conditional CAPM would fail as market beta variation would produce higher short duration premium during low $\sigma(Dur)$ periods, which is counterfactual (see column β_m). Similarly, exposure to cash flow shocks (as in Lettau and Wachter (2007, 2011)) predicts that the period of highest risk for the short duration strategy is the moderate $\sigma(Dur)$ period, when the short duration premium is only 5.6% (see column $\beta_{\Delta d}$). Further exploring time variation in the short duration premium is an interesting task for future research.

4 Exploring Other Equity Duration Measures

This section explores alternative equity duration measures. Subsection 4.1 demonstrates that equity duration measures that do not require a discount rate estimate, dr, yield short duration premia (and link to reinvestment risk) that are similar to my baseline results. Subsection 4.2 shows that my equity duration measure, Dur, improves upon the equity duration measure proposed in Dechow, Sloan, and Soliman (2004) on theoretical and empirical grounds.

4.1 Two Alternative Equity Duration Measures

a) Defining Alternative Measures of Equity Duration

The first alternative measure of equity duration I use keeps the non-linearity of Dur without requiring a firm discount rate. Specifically, I define expected payback period (EPP) as the investment horizon that solves:

$$\begin{aligned} ME_t &= \sum_{h=1}^{EPP_t} \mathbb{E}_t\left[PO_{t+h}\right] \\ &= \sum_{h=1}^{EPP_t} BE_t \cdot \left[e^{(\mathbf{1}_{CSprof}-\mathbf{1}_{BEg})'\Gamma^h s_t + v_1(h)} - 1\right] e^{v_2(h)+\mathbf{1}_{BEg}'(\sum_{\tau=1}^{h}\Gamma^\tau)\cdot s_t} \end{aligned} \tag{14}$$

where the second equality follows from equations 5 and the VAR process in equation 4.

Finding EPP does not require a firm discount rate, and thus its value comes purely from cash flow timing. EPP answers the question: "In expectation, how long will it take to recover the capital invested purely from cash flows." I use a root-finding algorithm for each firm/year separately on equation 14 to solve for EPP_t given s_t and the VAR parameter estimates.

The second alternative measure of equity duration keeps the concept of duration but ignores part of the inherent non-linearity in Dur to eliminate the need for a discount rate to calculate duration. Specifically, I develop a log-linear approximation to firm value and use it to calculate a log-linear duration ($llDur = -\partial ln(ME)/\partial dr$), which does not depend on the firm discount rate. The derivation details are provided in Internet Appendix A and the final expression is given by:

$$
\begin{aligned}
llDur_t &= \sum_{h=1}^{\infty}\left\{\prod_{\tau=0}^{h-1}\frac{e^{\mathbb{E}_t[mb_{t+\tau}]}}{e^{\mathbb{E}_t[mb_{t+\tau}]}+e^{\mathbb{E}_t[CSprof_{t+\tau}-BEg_{t+\tau}]}-1}\right\}\\
&= \sum_{h=1}^{\infty}\left\{\prod_{\tau=0}^{h-1}\frac{e^{\mathbf{1}'_{mb}\Gamma^h s_t}}{e^{\mathbf{1}'_{mb}\Gamma^\tau s_t}+e^{(\mathbf{1}_{CSprof}-\mathbf{1}_{BEg})'\Gamma^\tau s_t}-1}\right\} \qquad (15)
\end{aligned}
$$

where mb is the log market-to-book ratio and the second equality follows from the VAR process in equation 4.

For both EPP and $llDur$, the (out-of-sample) VAR estimation is identical to the one used for Dur and is described in Section 1.

b) Empirical Results using the Alternative Measures of Equity Duration

Internet Appendix Table IA.5 shows correlation matrices between the duration measures (and duration portfolio returns) I construct. Dur, EPP, and $llDur$ are strongly positively correlated, with the lowest correlation reported being 82% (between Dur and $llDur$).

Table 7 shows my main results after replacing Dur with EPP (Panel A) or $llDur$ (Panel B). I focus on value-weighted returns when describing results. The duration premium is very similar whether I use EPP (9.1% with t_{stat} = 3.23) or $llDur$ (9.3% with t_{stat} = 3.25) to capture duration. For both measures, the premium remains strong over a period of five years and when I focus only on large companies. Moreover, αs relative to the ICAPM presented in subsection 3.1 are small and insignificant (risk premia estimates are provided in Internet Appendix Table IA.4). Finally, in both cases, the favorable ICAPM performance is driven by reinvestment risk, with long duration portfolios being better hedges against declines in equity expected returns.

Overall, the results indicate that the short duration premium and its link to reinvestment risk remain similar after replacing Dur by two alternative measures of cash flow duration (EPP and $llDur$) that do not require a discount rate estimate.

4.2 Comparison with Dechow, Sloan, and Soliman (2004)

In an important contribution, Dechow, Sloan, and Soliman (2004) (henceforth DSS) provide a measure of equity duration and study some of its properties. This subsection contrasts DSS's equity duration measure ($DSS\ Dur$) with the one I develop in this paper (Dur) both on theoretical and empirical grounds to demonstrate that Dur improves upon $DSS\ Dur$ on several dimensions.

a) Theoretical Comparison Between *Dur* and *DSS Dur*

Duration can be generally defined as in equation 1. I use a VAR model to get expressions for the cash flow expectations, $\mathbb{E}_t[CF_{t+h}]$, in equation 1 and calculate duration. In contrast, DSS make several assumptions to deal with the same cash flow issue. First, DSS split equation 1 into the cash flows until (an arbitrary) time $t+H$ and the cash flows after that:

$$\begin{aligned} DSS\ Dur_t &= \sum_{h=1}^{H} w_{t,h} \cdot h + \sum_{h=H+1}^{\infty} w_{t,h} \cdot h \\ &= \sum_{h=1}^{H} w_{t,h} \cdot h + \left(1 - \sum_{h=1}^{H} w_{t,h}\right) \cdot \left(H + \frac{e^{dr_t}}{e^{dr_t} - 1}\right) \end{aligned} \tag{16}$$

where $w_{t,h} = (\mathbb{E}_t\left[CF_{t+h}\right] \cdot e^{-h \cdot dr_t})/ME_t$ and $ME_{t,T} = \sum_{h=1}^{H} \mathbb{E}_t\left[CF_{t+h}\right] \cdot e^{-h \cdot dr_t}$.

The second equality follows from the (strong) assumption that cash flows after time $t+H$ are fixed, which makes the second component of the duration equation a level perpetuity with value $ME_t - ME_{t,T}$ and duration $H + (e^{dr_t}/e^{dr_t} - 1)$ as of time t.

To get expectations for cash flows from $t+1$ to $t+H$, DSS assume clean surplus accounting holds such that clean surplus earnings can be replaced by accounting earnings (measured as income before extraordinary items) to get $CF_t = E_t - \Delta BE_t$, which implies:

$$\begin{aligned} \mathbb{E}_t\left[CF_{t+h}\right] &= \mathbb{E}_t\left[BE_{t+h-1}\left(\frac{E_{t+h}}{BE_{t+h-1}} - \frac{\Delta BE_{t+h}}{BE_{t+h-1}}\right)\right] \\ &= \mathbb{E}_t\left[BE_{t+h-1} \cdot (ROE_{t+h} - BEG_{t+h})\right] \end{aligned} \tag{17}$$

DSS then assume book equity growth (BEG_t) and return on equity (ROE_t) follow univariate autoregressive processes and that sales growth (YG_t) is the right predictor for book equity growth so that $\mathbb{E}_t[BEG_{t+h}] = \overline{G} + \rho_G^h \cdot (YG_t - \overline{G})$, $\mathbb{E}_t[BE_{t+h-1}] = BE_t \cdot [1 + \overline{G} + \rho_G^{h-1} \cdot (YG_t - \overline{G})]$, and $\mathbb{E}_t[ROE_{t+h}] = \overline{ROE} + \rho_{ROE}^h \cdot (ROE_t - \overline{ROE})$. Consequently, $DSS\ Dur$ is based on the following cash flow forecast:

$$\begin{aligned} \mathbb{E}_t\left[CF_{t+h}\right] =& BE_t \cdot [1 + \overline{G} + \rho_G^{h-1} \cdot (YG_t - \overline{G})] \\ & \times \left[\overline{ROE} + \rho_{ROE}^h \cdot (ROE_t - \overline{ROE}) - \overline{G} - \rho_G^h \cdot (YG_t - \overline{G})\right] \end{aligned} \tag{18}$$

which, together with an exogenously imposed dr, allows DSS to recover $w_{t,h}$ for $h = 1, ..., H$ and calculate $DSS\ Dur$.

While $DSS\ Dur$ is a very important first step in measuring equity duration, a few points make it clear that Dur improves upon $DSS\ Dur$ from a theoretical perspective.

First, the assumption of a level perpetuity is strong. It assumes cash flows no longer grow after year $t + H$. This induces a strong downward bias in $DSS\ Dur$. For instance, Weber (2018) reports an average duration of 6 years for the low duration decile and an average duration of 24 years for the high duration decile. Using the simple log linear approximation explained in footnote 9 (which only requires dividend yield to obtain duration), the aggregate duration is between 38.4 and 48.1 years, which is in line with estimates based on Dur (see Table 1), but much higher than the $DSS\ Dur$ of the high duration portfolio in Weber (2018).

Second, while Dur estimates expected cash flows directly from the dynamics of net payouts, which are cash flows to stockholders, $DSS\ Dur$ does not use cash flow information to measure the expectation of long-term cash flows. Specifically, the assumption that the level perpetuity to be received at time $t + H$ has value $ME_t - ME_{t,T}$ at time t implies $\mathbb{E}_t[CF_\infty] = (ME_t - ME_{t,T}) \cdot (1 - e^{-dr_t}) \cdot e^{-(H+1) \cdot dr_t}$ where CF_∞ is the (fixed, but unknown) cash flow to be received ever year from $t + H + 1$ to $t + \infty$.[29] Since dr is exogenously specified, the expectation of long-term cash flows to be paid by the firm is not based on the dynamics of cash flows (or earnings), but instead on the current market equity of the firm, ME, in

[29] To see this, note that the value of the level perpetuity is given by $\sum_{h=H+1}^{\infty} \mathbb{E}_t[CF_\infty] \cdot e^{-h \cdot dr_t} = \mathbb{E}_t[CF_\infty] \cdot e^{-(H+1) \cdot dr_t} / (1 - e^{-dr_t})$, which is assumed to be equal to $ME_t - ME_{t,T}$, yielding the given implied cash flow expectation.

excess of the present value of short-term cash flows, $ME_{t,T}$.

Third, even short-term expected cash flows in $DSS\ Dur$ are not estimated from the dynamics of cash flows, but instead from the dynamics of earnings. By replacing clean surplus earnings with accounting earnings, DSS is measures equity duration without ever using firm payout information. In contrast, Dur constructs clean surplus earnings from net payouts, effectively relying on cash flows to estimate duration.

Fourth, the assumptions imposed to derive $DSS\ Dur$ are internally inconsistent. To move from equation 17 to equation 18, DSS (implicitly) assume that $\mathbb{E}_t\left[BE_{t+h-1} \cdot (ROE_{t+h} - BEG_{t+h})\right] = \mathbb{E}_t[BE_{t+h-1}] \cdot \mathbb{E}_t[ROE_{t+h} - BEG_{t+h}]$, which requires lagged growth to be uncorrelated with current growth and ROE. The assumption that BEG follows a univariate process that depends on YG, which is autocorrelated, implies the zero correlation assumption cannot hold, and thus the assumptions are internally inconsistent.

Finally, the assumption of univariate autoregressive processes for ROE and growth can be viewed as a restriction on the more general assumption I make about a vector autoregressive process including these variables (in log units). As such, Dur can be seen as a generalization of $DSS\ Dur$.

Overall, $DSS\ Dur$ is an important first step in measuring equity duration, but Dur improves upon it on several theoretical aspects.

b) Empirical Comparison Between *Dur* and *DSS Dur*

Figure 4 replicates Figure 1 after replacing Dur with $DSS\ Dur$. Figures 4(a) and 4(b) show that $DSS\ Dur$ is, in fact, a measure of equity duration since firms in the short duration portfolio tend to pay more cash flows to investors (as a fraction of initial investment) over the short term than firms in the long duration portfolio. However, the pattern is not as strong as with Dur, with Figure 4(a) indicating decile 5 pays as much cash flows over the short term as decile 1. Similarly, Figures 4(c) and 4(d) indicate that long duration firms are more exposed to the dividend term structure, but the pattern is far from monotone and is only present at the longest duration deciles. The conclusion is that $DSS\ Dur$ captures equity duration, but not as well as *Dur*.

Table 8 replicates Table 2 after replacing *Dur* with *DSS Dur*. The short duration premium is smaller (6.6% and 8.1% in value- and equal-weighted returns) and delivers no α relative to Fama and French (2015)'s 5-Factor model or Hou, Xue, and Zhang (2015)'s q-Factor model whether we focus on value- or equal-weighted returns. This result, which is quantitatively similar to the findings in Hou, Xue, and Zhang (2015, 2019), indicates that *Dur* also improves upon *DSS Dur* in terms of providing a higher spread in average returns that is not fully captured by standard factor models.

c) Mispricing vs Reinvestment Risk

Weber (2018) finds a much larger *DSS Dur* short duration premium that is not fully captured by the Fama and French (2015)'s 5-Factor model and argues that market participants are overly optimistic about the prospects of long duration companies, inducing overvaluation for these companies, which leads to poor returns. The results in Table 8 do not represent a failure to replicate Weber (2018)'s finding. Specifically, Internet Appendix Table IA.6 replicates the results in Weber (2018) after matching his empirical specification (dropping the use of NYSE breakpoints, keeping microcaps in equal-weighted portfolios, and winsorizing returns at 1% and 99%).[30]

Overall, equity duration correlates with both mispricing and reinvestment risk. Given Weber (2018)'s goal of studying the effect of mispricing on the short duration premium, his empirical decisions put the spotlight on small firms. In contrast, my goal is to study the short duration premium that exists even in the absence of mispricing, which motivates my empirical decision to minimize the effect of mispricing by focusing on relatively large firms (through NYSE breakpoints in value-weighted portfolio or the removal of microcaps in equal-weighted portfolios).

The natural interpretation of the overall evidence (once we account for both papers) is that

[30]Internet Appendix Table IA.7 shows that the *Dur* short duration premium is also stronger after dropping the use of NYSE breakpoints, keeping Microcaps in equal-weighted portfolios, and winsorizing returns.

reinvestment risk and mispricing are complementary channels that help capture the short duration premium. Specifically, reinvestment risk justifies the existence of a short duration premium in the absence of mispricing while mispricing generates an even larger short duration premium among small firms.

5 Conclusion

In this paper, I develop a new measure of equity cash flow duration and use it to empirically study the premium for stocks with cash flows concentrated in the short term (i.e., the short duration premium). I find that several of the short duration premium properties (including its time variation) are consistent with the idea that reinvestment risk, defined as exposure to declines in expected wealth growth and priced by long-term investors, is its main driver. Moreover, I show that the value and profitability premia can be explained by the lower cash flow duration of value and profitable companies. My results build a novel empirical link between the cross-section of stock returns and the term structure of risk premia through reinvestment risk.

However, this paper also raises new questions. First, can we use stock price information to infer about the term structure of discount rates more directly? Second, can we use the information that equity duration is an indirect measure of reinvestment risk in order to create a tradable reinvestment risk factor? Third, what are the implications of equity duration to portfolio holdings of investors that differ in investment horizon? These are important avenues for future research related to equity duration and the term structure of risk premia.

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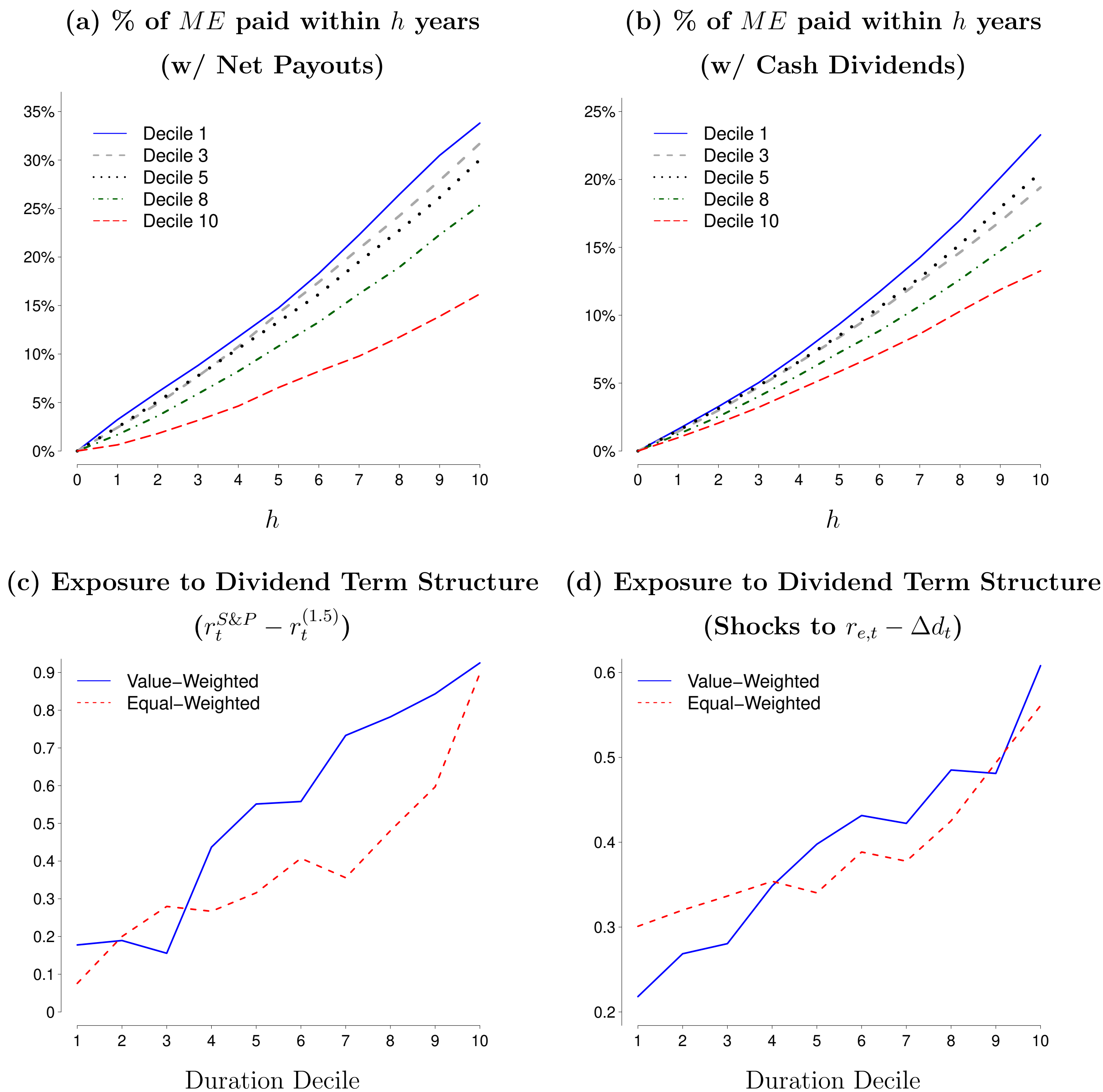
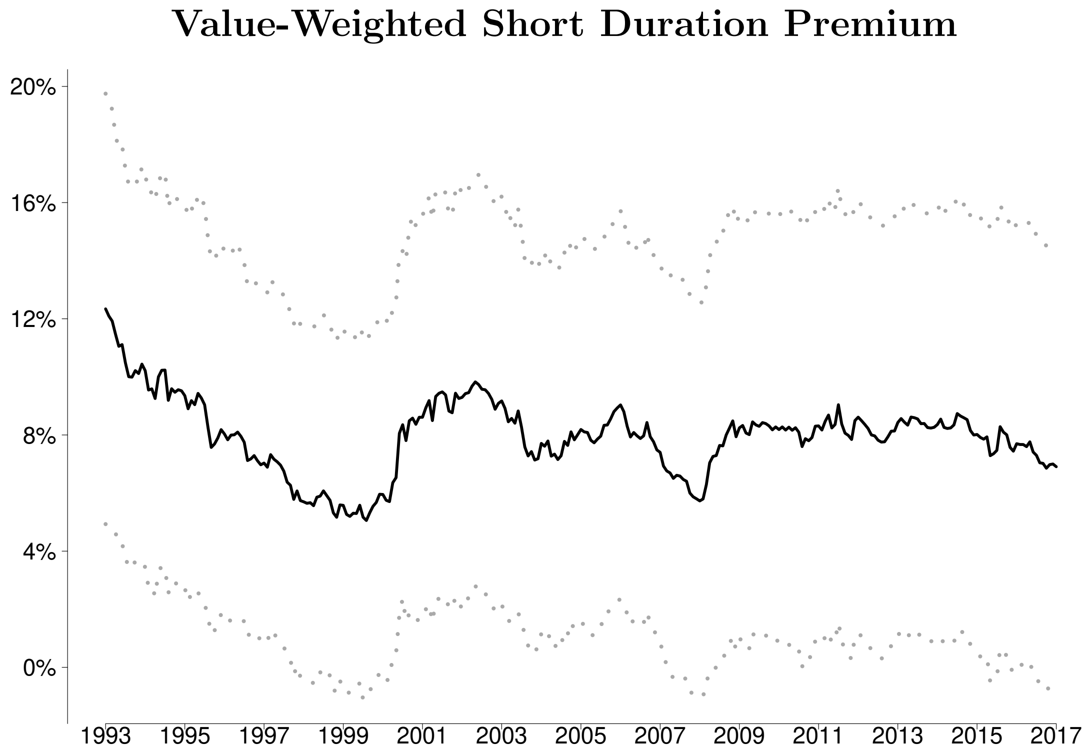


Figure 1
Validating Equity Duration Portfolios

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on Dur, which is measured from equation 7 (empirical details in Section 1). Graph (a) shows the cumulative fraction of market equity that firms in each duration decile pay (in net payouts) over the ten years following the duration measurement. Graph (b) repeats this analysis after replacing net payouts with cash dividends. Graphs (c) and (d) show the exposures (regression slopes) of duration portfolios (value-weighted and equal-weighted) to the dividend term structure, measured as returns on a long-short portfolio that buys a long-duration asset (an equity index) and sells a short-duration asset (a short-term dividend claim). Graph (c) uses annual log returns on the S&P500 as the long-duration asset and annual log returns on a S&P500 dividend claim (with approximately 1.5 year maturity) as the short duration asset (first annual return is in June/1997). Graph (d) provides results using (shocks to) annual log returns on the CRSP equity portfolio as the long-duration asset and (shocks to) annual log dividend growth on the same portfolio as the short-duration asset. All necessary details are provided in subsection 2.2.



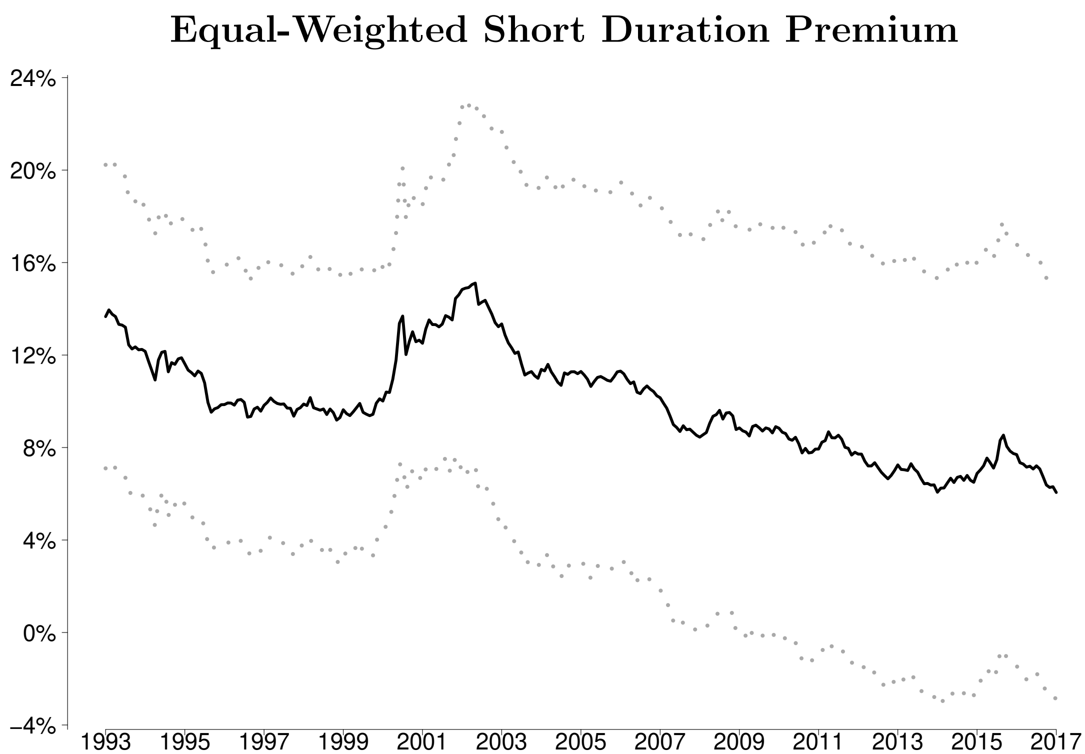


Figure 2
Short Duration Premium on a 20-Year Rolling Window

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on *Dur*, which is measured from equation 7 (empirical details in Section 1). The graphs report the short duration premium (decile 1 minus decile 10) on a rolling window of 20 years (solid line). The 95% confidence interval for the duration premium is also reported (dotted lines).

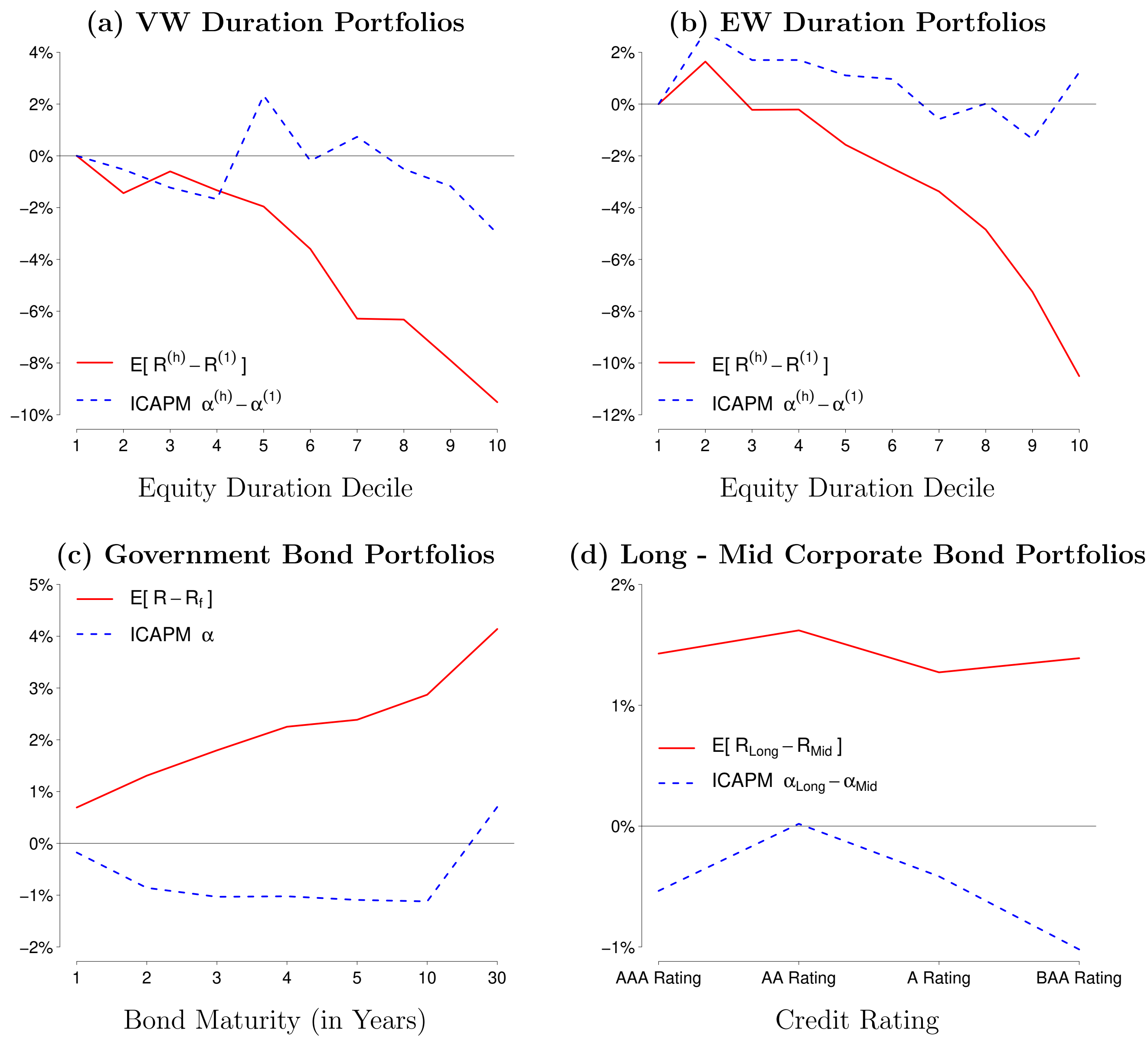


Figure 3
Risk Premia and ICAPM αs: Equity Duration Portfolios and Bond Portfolios

The graphs report average excess returns and ICAPM pricing errors (αs) for several long-short portfolios designed to capture the slopes of the equity and bond term structures. Risk prices come from the ICAPM estimation in column 5 of Table 5, which is based on the estimation of Equation 13 using as testing assets excess returns of (value- and equal-weighted) duration portfolios relative to the shortest duration portfolio ($R^{(h)}_{Dur} - R^{(1)}_{Dur}$). The estimation further requires the model to perfectly match the equity premium, $\mathbb{E}[R_e - R_f]$, with risk prices that obey the ICAPM pricing restrictions $\gamma \geq 0$ and $0 \leq \lambda_{\mathbb{E}r}/(\gamma - 1) \leq (1 - \phi^{49})/(1 - \phi)$.

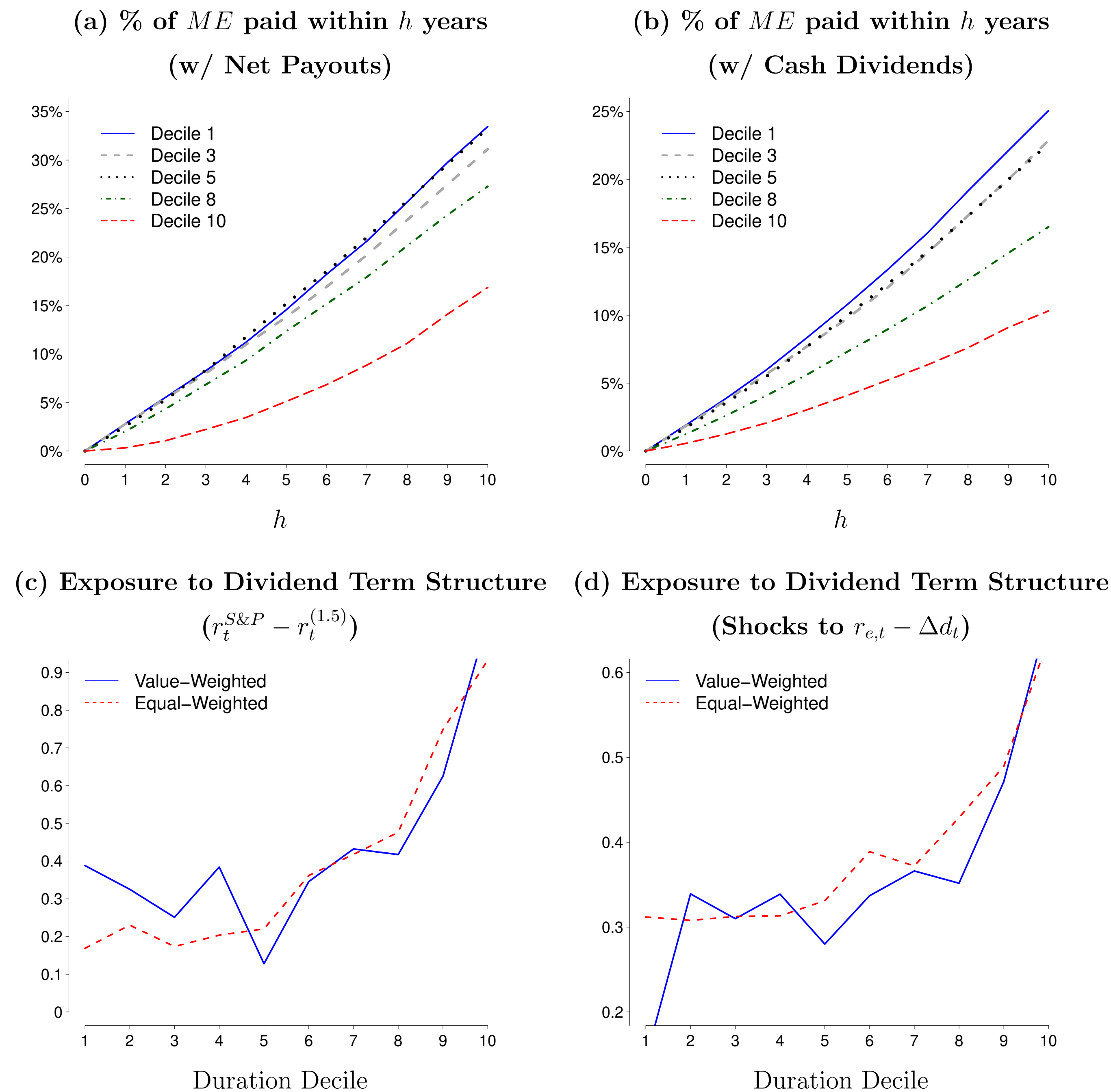


Figure 4
Validating Dechow, Sloan, and Soliman (2004) Duration Portfolios

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on *Dur*, which is measured from equation 16 (empirical details in Section 4.2). Graph (a) shows the cumulative fraction of market equity that firms in each duration decile pay (in net payouts) over the ten years following the duration measurement. Graph (b) repeats this analysis after replacing net payouts with cash dividends. Graphs (c) and (d) show the exposures (regression slopes) of duration portfolios (value-weighted and equal-weighted) to the dividend term structure, measured as returns on a long-short portfolio that buys a long-duration asset (an equity index) and sells a short-duration asset (a short-term dividend claim). Graph (c) uses annual log returns on the S&P500 as the long-duration asset and annual log returns on a S&P500 dividend claim (with approximately 1.5 year maturity) as the short duration asset (first annual return is in June/1997). Graph (d) provides results using (shocks to) annual log returns on the CRSP equity portfolio as the long-duration asset and (shocks to) annual log dividend growth on the same portfolio as the short-duration asset. All necessary details are provided in subsection 2.2.

Table 1
Summary Statistics for Firms in Duration Portfolios

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on Dur, which is measured from equation 7 (empirical details in Section 1). Panel A reports sample statistics at June of each year for all firms included in the duration portfolios. N is the total number of sample firms; $\%ME$ represents the percentage of market equity in my sample relative to a comparable sample that requires only ME and BE availability; and $q^{x}_{p\%}$ represents the p-th quantile of variable x based on the respective cross-section of firms. Panel B reports, for each portfolio, Dur, $Size = ln(ME)$, and the firm characteristics in the VAR state vector (defined in subsection 1.2). At each year, I take the value-weighted average of the respective characteristic within each duration portfolio and, at the end, take the time average of these aggregate characteristics separately for each portfolio. Statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)) with t_{stat} in parentheses.

PANEL A: Sample of Firms Included in Duration Portfolios

Year	N	%ME	$q^{Dur}_{10\%}$	$q^{Dur}_{50\%}$	$q^{Dur}_{90\%}$	$q^{BM}_{10\%}$	$q^{BM}_{50\%}$	$q^{BM}_{90\%}$	$q^{BEg}_{10\%}$	$q^{BEg}_{50\%}$	$q^{BEg}_{90\%}$	$q^{CSprof}_{10\%}$	$q^{CSprof}_{50\%}$	$q^{CSprof}_{90\%}$
1973	1,506	91.0%	5.6	23.7	67.6	0.3	0.80	1.70	-0.05	0.053	0.216	-0.042	0.077	0.190
1978	2,535	97.0%	6.1	17.9	42.4	0.5	1.16	2.43	-0.10	0.038	0.183	-0.069	0.070	0.188
1983	2,451	86.6%	11.7	34.4	77.1	0.3	0.85	1.91	-0.23	0.019	0.204	-0.229	0.049	0.188
1988	2,684	87.5%	16.9	42.2	104.3	0.3	0.82	1.80	-0.33	0.036	0.345	-0.356	0.051	0.237
1993	2,855	91.2%	21.7	52.6	119.2	0.2	0.59	1.54	-0.31	0.033	0.447	-0.407	0.043	0.267
1998	3,305	82.5%	29.4	60.5	145.8	0.2	0.46	1.20	-0.32	0.071	0.418	-0.412	0.092	0.316
2003	2,830	84.6%	15.9	42.8	100.2	0.2	0.73	2.05	-0.54	0.006	0.264	-0.604	0.019	0.242
2008	2,400	87.4%	25.6	49.7	108.4	0.2	0.49	1.23	-0.33	0.048	0.332	-0.335	0.093	0.314
2013	2,125	91.0%	20.2	41.4	96.5	0.2	0.56	1.40	-0.31	0.032	0.249	-0.338	0.084	0.272
2016	1,949	93.1%	23.2	45.8	122.3	0.2	0.47	1.46	-0.36	0.002	0.256	-0.418	0.070	0.297
Average	2,580	88.1%	17.9	40.7	99.6	0.3	0.75	1.82	-0.28	0.035	0.309	-0.320	0.062	0.256

PANEL B: Characteristics of Firms in each Duration Portfolio

Duration			Valuation			Growth			Profitability			Capital Structure		
Decile	Dur	$Size$	BE/M	PO/M	Y/M	BEg	Ag	Yg	$CSprof$	Roe	$Gprof$	$Mlev$	$Blev$	$Cash$
Short	17.7	7.6	1.44	0.046	3.97	0.017	0.004	0.014	0.072	0.099	0.377	0.286	0.168	0.117
2	26.2	8.3	0.96	0.040	2.52	0.042	0.031	0.036	0.107	0.127	0.384	0.236	0.178	0.112
3	31.7	8.8	0.78	0.037	1.89	0.052	0.047	0.046	0.128	0.141	0.381	0.214	0.187	0.115
4	36.3	9.3	0.67	0.040	1.55	0.046	0.042	0.042	0.134	0.149	0.364	0.199	0.192	0.114
5	40.6	9.6	0.57	0.037	1.32	0.061	0.056	0.055	0.148	0.160	0.356	0.183	0.195	0.118
6	45.1	9.9	0.50	0.036	1.07	0.058	0.062	0.054	0.158	0.166	0.355	0.176	0.206	0.110
7	50.7	9.9	0.46	0.029	0.89	0.067	0.070	0.075	0.151	0.156	0.330	0.183	0.216	0.114
8	57.7	9.8	0.40	0.024	0.81	0.065	0.080	0.074	0.141	0.145	0.317	0.187	0.226	0.111
9	70.4	9.4	0.35	0.014	0.72	0.108	0.132	0.106	0.152	0.125	0.289	0.210	0.258	0.107
Long	111.9	9.3	0.30	0.003	0.80	0.096	0.168	0.123	0.050	-0.035	0.225	0.290	0.308	0.115
L-S	94.2	1.8	-1.14	-0.042	-3.17	0.079	0.164	0.110	-0.021	-0.134	-0.153	0.004	0.140	-0.001
(t_{L-S})	(15.24)	(6.10)	(-6.31)	(-8.67)	(-5.51)	(2.52)	(7.44)	(7.36)	(-0.61)	(-3.64)	(-3.63)	(0.08)	(5.85)	(-0.12)

Table 2
Performance of Duration Portfolios: The Short Duration Premium

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on Dur, which is measured from equation 7 (empirical details in Section 1), and monthly portfolio returns span the subsequent twelve months (from July/1973 to June/2017). Panel A shows average returns ($\times 12$), volatilities ($\times\sqrt{12}$), and Sharpe Ratios ($\times\sqrt{12}$). Panel B reports αs ($\times 12$) and βs from factor regressions. Statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)) with t_{stat} in parentheses and p-value in brackets.

PANEL A: Average Returns, Volatilities, and Sharpe Ratios

Duration	**Value-Weighted Portfolios**						**Duration**	**Equal-Weighted Portfolios**					
Decile	$\overline{r}_{t\to t+1}$	$\overline{r}_{t\to t+5}$	$\overline{r}_{t+4\to t+5}$	$\overline{r}^{Large}_{t\to t+1}$	σ	$\overline{r}/\sigma$	**Decile**	$\overline{r}_{t\to t+1}$	$\overline{r}_{t\to t+5}$	$\overline{r}_{t+4\to t+5}$	$\overline{r}^{Large}_{t\to t+1}$	σ	$\overline{r}/\sigma$
Short	12.9%	11.8%	11.6%	10.4%	19.1%	0.67	**Short**	12.7%	12.5%	11.3%	10.8%	20.3%	0.63
2	11.7%	11.1%	10.7%	9.8%	18.0%	0.65	**2**	14.1%	13.2%	12.2%	9.4%	19.6%	0.72
3	12.2%	11.6%	11.4%	10.7%	17.0%	0.72	**3**	12.5%	12.6%	12.4%	11.5%	19.2%	0.65
4	11.3%	10.2%	8.1%	10.6%	16.3%	0.69	**4**	12.4%	12.3%	11.9%	10.8%	19.0%	0.66
5	10.9%	9.2%	7.4%	6.0%	16.9%	0.65	**5**	11.3%	11.8%	11.5%	8.0%	19.2%	0.59
6	9.1%	8.8%	8.8%	6.6%	16.0%	0.57	**6**	10.6%	11.1%	10.7%	8.2%	19.6%	0.54
7	7.0%	7.3%	7.7%	5.7%	16.4%	0.43	**7**	9.9%	10.4%	11.4%	6.6%	19.9%	0.50
8	7.0%	6.8%	6.8%	5.6%	17.2%	0.41	**8**	8.4%	9.4%	10.0%	7.3%	20.8%	0.40
9	5.5%	6.5%	7.3%	4.8%	18.7%	0.30	**9**	6.4%	7.5%	8.5%	5.2%	22.7%	0.28
Long	3.7%	4.7%	8.6%	3.2%	20.8%	0.18	**Long**	3.1%	5.5%	7.4%	4.7%	26.6%	0.12
L-S	-9.2%	-7.1%	-3.0%	-7.2%	15.1%	-0.61	**L-S**	-9.6%	-7.0%	-3.8%	-6.1%	15.1%	-0.64
(t_{L-S})	(-3.79)	(-3.97)	(-1.46)	(-2.55)	[0.03]	[0.00]	**(t_{L-S})**	(-3.35)	(-2.98)	(-1.59)	(-2.43)	[0.00]	[0.00]

PANEL B: Risk-Adjusted Performance Based on Factor Models

Duration	**CAPM**		Fama and French (2015) **5-Factors**						Hou, Xue, and Zhang (2015) **q-Factors**				
Decile	α_{CAPM}	β_{MKT}	α_{FF}	β_{MKT}	β_{SMB}	β_{HML}	β_{CMA}	β_{RMW}	α_q	β_{MKT}	β_{SIZE}	β_{INV}	β_{ROE}
						Value-Weighted Portfolios							
Short	5.5%	0.96	0.8%	0.98	0.68	0.34	0.11	0.20	2.9%	0.92	0.56	0.42	-0.15
2	4.7%	0.98	1.6%	0.98	0.48	0.23	0.03	0.17	3.2%	0.95	0.39	0.22	-0.06
3	5.5%	0.94	2.2%	0.97	0.36	0.15	0.09	0.31	3.1%	0.93	0.28	0.18	0.11
4	4.6%	0.93	2.4%	0.97	0.11	0.09	0.14	0.16	2.9%	0.95	0.08	0.20	0.06
5	4.3%	0.95	2.4%	0.99	0.13	-0.12	0.35	0.12	2.7%	0.96	0.14	0.12	0.10
6	2.7%	0.91	0.7%	0.96	0.06	-0.08	0.24	0.23	1.0%	0.94	0.03	0.14	0.13
7	0.2%	0.96	0.2%	0.96	-0.01	-0.08	-0.05	0.14	0.4%	0.97	-0.05	-0.09	0.08
8	-0.3%	1.01	-0.3%	1.03	-0.06	-0.17	0.19	0.01	0.2%	1.02	-0.08	0.00	-0.01
9	-2.6%	1.12	-2.6%	1.11	0.04	-0.10	0.00	0.11	-1.2%	1.10	-0.03	-0.16	0.00
Long	-5.0%	1.24	-4.3%	1.19	0.13	-0.13	-0.06	-0.02	-3.8%	1.20	0.10	-0.20	-0.01
L-S	-10.5%	0.28	-5.1%	0.21	-0.55	-0.47	-0.17	-0.22	-6.8%	0.28	-0.47	-0.62	0.15
(t_{L-S})	(-3.94)	(4.20)	(-2.91)	(3.24)	(-4.65)	(-2.82)	(-1.18)	(-2.17)	(-3.08)	(4.50)	(-3.69)	(-3.61)	(0.98)
						Equal-Weighted Portfolios							
Short	4.8%	1.05	-1.1%	1.06	0.89	0.44	0.07	0.32	1.0%	1.01	0.75	0.54	-0.11
2	6.4%	1.08	2.3%	1.05	0.77	0.31	-0.01	0.21	4.1%	1.01	0.66	0.28	-0.11
3	4.5%	1.09	1.3%	1.05	0.67	0.24	-0.01	0.13	2.8%	1.02	0.58	0.19	-0.11
4	4.7%	1.08	1.5%	1.06	0.62	0.13	0.08	0.19	2.9%	1.02	0.54	0.16	-0.04
5	3.4%	1.10	0.5%	1.07	0.59	0.14	0.05	0.16	1.9%	1.04	0.51	0.13	-0.06
6	2.4%	1.13	0.4%	1.07	0.58	0.10	-0.06	0.14	1.9%	1.05	0.48	0.02	-0.09
7	1.6%	1.16	0.2%	1.10	0.50	0.07	-0.06	0.06	1.7%	1.09	0.41	-0.03	-0.12
8	-0.3%	1.21	-1.8%	1.15	0.50	-0.02	0.03	0.08	-0.2%	1.14	0.41	-0.03	-0.10
9	-3.1%	1.31	-4.0%	1.22	0.56	-0.13	0.06	0.03	-2.6%	1.22	0.47	-0.11	-0.12
Long	-7.6%	1.50	-6.0%	1.32	0.61	-0.08	-0.21	-0.32	-3.2%	1.33	0.47	-0.30	-0.49
L-S	-12.4%	0.45	-4.9%	0.26	-0.28	-0.52	-0.28	-0.64	-4.2%	0.33	-0.29	-0.84	-0.38
(t_{L-S})	(-4.19)	(5.28)	(-2.43)	(5.29)	(-2.98)	(-3.61)	(-1.82)	(-4.16)	(-1.93)	(6.44)	(-2.60)	(-4.54)	(-1.94)

Table 3
Panel Regressions of Returns on Portfolio Deciles

Portfolios are formed every June (1973 to 2016) from deciles based on the respective characteristics, which are described in Section 1. The table reports results from panel regressions of portfolio returns on the lagged deciles for the respective variables. Subsection 2.4 provides details on the methodology. Columns 1.1 and 2.1 are based on univariate regressions while all other columns rely on multivariate regressions using deciles from the firm-level characteristics. Each of the columns 1.1 to 1.8 only include in the panel data the decile portfolios of characteristics accounted for in the respective regression specification. For instance, column 1.2 uses twenty deciles, ten from duration and ten from book-to-market. Columns 2.1 to 2.7 keep all fifty decile portfolios irrespective of the regression specification. t_{stat} are in parentheses and statistical inference is based on the method in Driscoll and Kraay (1998), which is the natural generalization of Newey and West (1987, 1994) to a panel data setting and is robust to heteroskedasticity, autocorrelation, and cross-sectional correlation between portfolio returns.

PANEL A: Value-Weighted Portfolios

Sorting	Decile Portfolios Based on Included Covariates								All 50 Decile Portfolios						
Variable	[1.1]	[1.2]	[1.3]	[1.4]	[1.5]	[1.6]	[1.7]	[1.8]	[2.1]	[2.2]	[2.3]	[2.4]	[2.5]	[2.6]	[2.7]
Dur	-9.1%	-10.2%	-12.7%	-10.6%	-10.2%		-13.9%	-15.8%	-14.9%	-14.4%	-15.1%	-14.0%	-14.1%		-15.6%
	(-4.09)	(-4.27)	(-4.48)	(-4.13)	(-4.44)		(-3.03)	(-2.62)	(-4.94)	(-4.23)	(-4.80)	(-4.33)	(-4.50)		(-2.60)
BE/ME	5.1%	0.7%				12.6%	-1.5%	-4.1%	8.1%	0.8%				14.1%	-0.7%
	(2.12)	(0.23)				(3.29)	(-0.28)	(-0.59)	(2.57)	(0.24)				(3.90)	(-0.10)
Gprof	1.3%		-2.2%			9.6%	-2.5%	-2.9%	1.2%		-1.1%			10.6%	-1.6%
	(0.58)		(-0.85)			(2.70)	(-0.52)	(-0.50)	(0.42)		(-0.38)			(3.56)	(-0.29)
Ag	-3.9%			-3.0%				-3.8%	-8.6%			-3.5%			
	(-2.11)			(-1.29)				(-1.03)	(-2.37)			(-0.94)			
Size	-4.3%				-2.7%			-3.0%	-6.5%				-2.4%		
	(-1.82)				(-1.06)			(-1.05)	(-2.20)				(-0.83)		

PANEL B: Equal-Weighted Portfolios

Sorting	Decile Portfolios Based on Included Covariates								All 50 Decile Portfolios						
Variable	[1.1]	[1.2]	[1.3]	[1.4]	[1.5]	[1.6]	[1.7]	[1.8]	[2.1]	[2.2]	[2.3]	[2.4]	[2.5]	[2.6]	[2.7]
Dur	-9.2%	-9.0%	-9.8%	-9.1%	-9.9%		-9.0%	-8.9%	-11.9%	-10.9%	-12.1%	-10.5%	-11.9%		-9.6%
	(-4.41)	(-3.42)	(-4.06)	(-4.09)	(-4.55)		(-1.93)	(-1.87)	(-4.90)	(-4.13)	(-4.56)	(-4.53)	(-4.76)		(-2.00)
BE/ME	6.1%	1.9%				9.2%	2.2%	1.7%	8.5%	1.6%				11.9%	3.1%
	(2.48)	(0.65)				(3.27)	(0.43)	(0.32)	(3.21)	(0.57)				(4.13)	(0.59)
Gprof	4.1%		-0.2%			7.6%	1.1%	1.8%	3.9%		-0.7%			9.1%	1.6%
	(2.12)		(-0.09)			(3.40)	(0.24)	(0.41)	(1.70)		(-0.30)			(3.77)	(0.36)
Ag	-5.7%			-4.2%				-4.0%	-9.3%			-4.0%			
	(-3.71)			(-2.60)				(-2.52)	(-3.96)			(-2.01)			
Size	-2.1%				-0.2%			0.2%	-3.8%				0.0%		
	(-1.11)				(-0.12)			(0.11)	(-1.65)				(-0.01)		

Table 4
Risk Exposures (βs) of Duration Portfolios

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on Dur, which is measured from equation 7 (empirical details in Section 1). The table reports average excess returns, $\overline{r}$, market risk, β_m, reinvestment risk, $\beta_{\mathbb{E}r}$, as well as betas relative to dividend yield, β_{dp}, net payout yield, β_{poy}, and dividend growth, $\beta_{\Delta d}$. All statistics are based on annual returns (July/t to June/t+1) and betas are the regression slopes of log returns on shocks to risk factors. t_{stat} are in parentheses and statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)).

Duration	**Value-Weighted**						**Equal-Weighted**					
Decile	$\overline{r}$	β_m	$\beta_{\mathbb{E}r}$	β_{dp}	β_{poy}	$\beta_{\Delta d}$	$\overline{r}$	β_m	$\beta_{\mathbb{E}r}$	β_{dp}	β_{poy}	$\beta_{\Delta d}$
Short	13.5%	0.67	-0.42	-0.24	-0.18	0.13	13.2%	0.64	-0.36	-0.32	-0.24	-0.03
2	12.1%	0.66	-0.49	-0.25	-0.19	0.04	14.8%	0.75	-0.74	-0.33	-0.32	0.02
3	12.9%	0.72	-0.47	-0.26	-0.21	0.06	13.0%	0.80	-0.92	-0.34	-0.34	0.03
4	12.2%	0.90	-0.92	-0.29	-0.30	0.08	13.0%	0.79	-0.91	-0.36	-0.36	-0.01
5	11.6%	0.85	-1.27	-0.34	-0.46	-0.04	11.6%	0.76	-0.92	-0.34	-0.31	-0.01
6	9.9%	0.90	-1.29	-0.37	-0.39	-0.06	10.7%	0.81	-1.10	-0.38	-0.38	-0.05
7	7.2%	0.74	-1.27	-0.38	-0.33	-0.16	9.8%	0.79	-0.99	-0.36	-0.37	-0.05
8	7.2%	0.83	-1.36	-0.43	-0.37	-0.20	8.3%	0.86	-1.36	-0.41	-0.41	-0.08
9	5.6%	0.92	-1.68	-0.44	-0.39	-0.12	5.9%	0.95	-1.68	-0.47	-0.45	-0.12
Long	4.0%	1.19	-2.27	-0.56	-0.51	-0.14	2.7%	1.09	-2.59	-0.53	-0.64	-0.13
L-S	-9.5%	0.52	-1.85	-0.31	-0.33	-0.27	-10.5%	0.46	-2.22	-0.21	-0.39	-0.10
(t_{L-S})	(-3.28)	(4.92)	(-8.02)	(-3.43)	(-2.37)	(-1.35)	(-3.48)	(2.72)	(-3.92)	(-1.69)	(-2.66)	(-0.53)

Table 5
ICAPM Estimation and Pricing Errors (αs) of Duration Portfolios

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on Dur, which is measured from equation 7 (empirical details in Section 1). Panel A reports risk prices and pricing errors (αs) for the estimation of Equation 13 using as testing assets excess returns of (value- and equal-weighted) duration portfolios relative to the shortest duration portfolio ($R^{(h)}_{Dur} - R^{(1)}_{Dur}$). Panel B further requires the model to perfectly match the equity premium, $\mathbb{E}[R_e - R_f]$. The CAPM specification imposes $\gamma \geq 0$ and $\lambda_{\mathbb{E}r} = 0$, the ICAPM specification imposes $\gamma \geq 0$ and $0 \leq \lambda_{\mathbb{E}r}/(\gamma - 1) \leq (1-\phi^{49})/(1-\phi)$, and the ICAPM$_{\text{U}}$ specification imposes no restriction on risk prices. Subsection 3.1 explains the construction of risk factors and Internet Appendix C provides details for the model estimation and inference. t_{stat} are in parentheses and statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)).

		PANEL A - Matches $\mathbb{E}[R^{(h)}_{Dur} - R^{(1)}_{Dur}]$			PANEL B - Also Imposes $\mathbb{E}[R_e - R_f]$		
		CAPM	***ICAPM***	***ICAPM$_U$***	***CAPM***	***ICAPM***	***ICAPM$_U$***
	$\lambda_m = \gamma$	0.0	6.4	6.4	3.6	10.6	10.6
		(0.00)	(3.26)	(2.33)	(-)	(6.20)	(6.07)
	$\lambda_{\mathbb{E}r}$		20.4	20.4		25.5	25.5
			(3.67)	(3.67)		(4.10)	(4.02)
	implied H	1	6		1	4	
	implied δ		0.87			0.80	
	$\mathbb{E}[R_e - R_f]$	0.0%	1.6%	1.6%	7.1%	7.1%	7.1%
	α_{2-1}	-1.4%	-0.8%	-0.8%	-1.3%	-0.5%	-0.5%
	α_{3-1}	-0.6%	-0.9%	-0.9%	-1.0%	-1.2%	-1.2%
	α_{4-1}	-1.3%	-0.6%	-0.6%	-3.2%	-1.7%	-1.7%
	α_{5-1}	-2.0%	2.3%	2.3%	-3.4%	2.3%	2.3%
VW	α_{6-1}	-3.6%	0.2%	0.2%	-5.4%	-0.2%	-0.2%
	α_{7-1}	-6.3%	-0.4%	-0.4%	-6.8%	0.7%	0.7%
	α_{8-1}	-6.3%	-1.0%	-1.0%	-7.5%	-0.5%	-0.5%
	α_{9-1}	-7.9%	-1.4%	-1.4%	-9.9%	-1.2%	-1.2%
	α_{10-1}	-9.5%	-2.0%	-2.0%	-13.6%	-3.0%	-3.0%
	(t^{α}_{10-1})	(-3.18)	(-0.67)	(-0.67)	(-4.55)	(-1.00)	(-1.00)
	α_{2-1}	1.6%	3.1%	3.1%	0.8%	2.8%	2.8%
	α_{3-1}	-0.2%	2.0%	2.0%	-1.5%	1.7%	1.7%
	α_{4-1}	-0.2%	2.0%	2.0%	-1.4%	1.7%	1.7%
	α_{5-1}	-1.6%	1.1%	1.1%	-2.6%	1.1%	1.1%
EW	α_{6-1}	-2.5%	1.0%	1.0%	-3.8%	1.0%	1.0%
	α_{7-1}	-3.4%	-0.5%	-0.5%	-4.6%	-0.6%	-0.6%
	α_{8-1}	-4.8%	0.0%	0.0%	-6.6%	0.0%	0.0%
	α_{9-1}	-7.3%	-1.1%	-1.1%	-9.7%	-1.4%	-1.4%
	α_{10-1}	-10.5%	0.9%	0.9%	-14.1%	1.2%	1.2%
	(t^{α}_{10-1})	(-3.49)	(0.30)	(0.30)	(-4.68)	(0.41)	(0.41)

Table 6
Time Variation in the Short Duration Premium

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on Dur, which is measured from equation 7 (empirical details in Section 1). $\sigma(Dur)$ represents the cross-sectional standard deviation of $ln(Dur)$, with the logarithm transformation being used to decrease the large asymmetry in duration and the potential influence of outliers. The table reports results (average excess market returns as well as average returns and risk exposures of the long-short duration portfolio) separately for periods of low $\sigma(Dur)$ (lower 25% observations), moderate $\sigma(Dur)$, and high $\sigma(Dur)$ (highest 25% observations). Taking the low $\sigma(Dur)$ period as an example, I select the years (t) with the 25% lowest $\sigma(Dur)$, collect returns and risk factors from July of year $t+1$ to June of year $t+2$ (same time convention as the portfolio formation), and calculate average returns and covariances based on this subset of years. I provide t_{stat} for the tests comparing the low $\sigma(Dur)$ period with the respective (moderate or high) $\sigma(Dur)$ period. Statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)).

$\boldsymbol{\sigma(Dur)}$	$\bar{r}_e$	$\bar{r}_{10-1}$	β_m	$\beta_{\mathbb{E}r}$	β_{dp}	β_{poy}	$\beta_{\Delta d}$
		Value-Weighted					
Low	6.90%	-4.8%	0.49	-1.01	-0.18	0.58	0.15
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Moderate	7.9%	-5.6%	0.52	-1.35	-0.47	-0.41	-0.77
	(0.17)	(-0.15)	(0.11)	(-0.25)	(-1.15)	(-1.84)	(-3.31)
High	5.9%	-20.8%	0.53	-2.55	-0.51	-0.89	-0.53
	(-0.14)	(-2.29)	(0.18)	(-1.19)	(-1.34)	(-2.72)	(-2.20)
$\boldsymbol{R^2}$ =	-4.6%	11.1%					
		Equal-Weighted					
Low	6.9%	-5.2%	0.30	-0.10	-0.09	0.42	0.18
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Moderate	7.9%	-6.8%	0.47	-1.69	-0.43	-0.46	-0.61
	(0.17)	(-0.34)	(0.48)	(-2.95)	(-1.34)	(-2.99)	(-2.32)
High	5.9%	-21.8%	0.58	-3.61	-0.31	-1.00	-0.24
	(-0.14)	(-2.67)	(0.99)	(-3.37)	(-0.77)	(-3.69)	(-1.02)
$\boldsymbol{R^2}$ =	-4.6%	8.5%					

Table 7
Risk and Average Returns of Alternative Duration Portfolios

Equity duration portfolios are formed every June from 1973 to 2016 based on deciles constructed from EPP and $llDur$ (details in subsection 4.1). The table reports average returns, $\bar{r}$ ($\times 12$), ICAPM pricing errors based on equation 13, α_{ICAPM}, market risk, β_m, and reinvestment risk, $\beta_{\mathbb{E}r}$. Statistics related to the ICAPM are based on annual returns (July/t to June/t+1) and betas are the regression slopes of log returns on shocks to risk factor. Statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)) with t_{stat} in parentheses.

PANEL A: Duration = EPP_t

Duration	Value-Weighted Portfolios						Duration	Equal-Weighted Portfolios					
Decile	$\bar{r}_{t\to t+1}$	$\bar{r}_{t\to t+5}$	$\bar{r}^{Large}_{t\to t+1}$	α_{ICAPM}	β_m	$\beta_{\mathbb{E}r}$	Decile	$\bar{r}_{t\to t+1}$	$\bar{r}_{t\to t+5}$	$\bar{r}^{Large}_{t\to t+1}$	α_{ICAPM}	β_m	$\beta_{\mathbb{E}r}$
Short	12.6%	11.8%	10.4%	0.0%	0.64	-0.37	**Short**	12.7%	12.5%	10.4%	0.0%	0.64	-0.29
2	11.5%	10.8%	10.4%	2.8%	0.61	-0.36	**2**	14.1%	13.0%	10.5%	-0.8%	0.77	-0.75
3	12.3%	11.4%	9.4%	1.9%	0.72	-0.46	**3**	12.5%	12.6%	10.4%	-1.2%	0.73	-0.79
4	11.0%	10.2%	9.2%	1.0%	0.94	-0.68	**4**	12.5%	12.3%	9.9%	-5.0%	0.81	-0.84
5	10.9%	9.6%	9.1%	0.2%	0.88	-0.82	**5**	11.4%	11.7%	9.4%	-2.6%	0.78	-0.84
6	9.2%	9.3%	5.1%	0.7%	0.80	-1.18	**6**	10.7%	11.6%	7.2%	0.2%	0.82	-1.08
7	8.6%	7.9%	7.7%	-1.7%	0.78	-0.97	**7**	9.7%	10.3%	7.9%	-1.9%	0.77	-0.84
8	8.6%	7.5%	6.0%	-0.4%	0.88	-1.17	**8**	8.6%	9.4%	7.9%	-2.4%	0.87	-1.35
9	5.9%	6.4%	4.8%	0.1%	0.89	-1.62	**9**	6.2%	8.0%	4.5%	-1.8%	0.93	-1.88
Long	3.6%	4.8%	2.1%	1.7%	1.17	-2.63	**Long**	3.0%	5.1%	4.4%	-1.2%	1.11	-2.90
L-S	-9.1%	-6.9%	-8.4%	1.7%	0.53	-2.26	**L-S**	-9.7%	-7.4%	-6.0%	-1.2%	0.47	-2.61
(t_{L-S})	(-3.23)	(-3.60)	(-2.47)	(0.6)	(4.47)	(-5.72)	**(t_{L-S})**	(-3.25)	(-2.97)	(-2.23)	(-0.4)	(2.71)	(-4.03)

PANEL B: Duration = $llDur_t$

Duration	Value-Weighted Portfolios						Duration	Equal-Weighted Portfolios					
Decile	$\bar{r}_{t\to t+1}$	$\bar{r}_{t\to t+5}$	$\bar{r}^{Large}_{t\to t+1}$	α_{ICAPM}	β_m	$\beta_{\mathbb{E}r}$	Decile	$\bar{r}_{t\to t+1}$	$\bar{r}_{t\to t+5}$	$\bar{r}^{Large}_{t\to t+1}$	α_{ICAPM}	β_m	$\beta_{\mathbb{E}r}$
Short	12.1%	11.4%	10.3%	0.0%	0.72	-0.27	**Short**	13.4%	12.6%	11.5%	0.0%	0.64	-0.29
2	12.1%	10.8%	9.0%	0.4%	0.59	-0.26	**2**	13.2%	12.7%	10.0%	2.2%	0.75	-0.61
3	11.3%	10.3%	8.1%	-1.6%	0.76	-0.51	**3**	11.7%	12.0%	9.0%	0.2%	0.75	-0.61
4	10.5%	10.1%	9.2%	-0.6%	0.86	-0.46	**4**	11.5%	12.1%	9.3%	-3.0%	0.83	-0.93
5	10.1%	9.2%	7.9%	-0.2%	0.90	-0.98	**5**	12.0%	11.8%	8.9%	-0.1%	0.84	-0.96
6	9.0%	8.7%	7.8%	-0.2%	0.79	-0.76	**6**	11.4%	11.2%	8.3%	-0.9%	0.79	-0.94
7	9.5%	8.8%	5.8%	-0.2%	0.74	-0.83	**7**	9.6%	10.5%	7.3%	1.2%	0.84	-1.30
8	7.4%	7.4%	6.0%	-0.8%	0.79	-1.12	**8**	8.5%	9.6%	7.0%	0.1%	0.91	-1.54
9	7.4%	6.7%	5.9%	0.1%	0.96	-1.80	**9**	7.5%	8.5%	7.6%	2.6%	0.88	-1.74
Long	2.8%	4.6%	1.7%	-0.3%	1.20	-2.53	**Long**	2.6%	5.5%	3.5%	-1.4%	1.00	-2.63
L-S	-9.3%	-6.8%	-8.5%	-0.3%	0.48	-2.26	**L-S**	-10.8%	-7.2%	-7.9%	-1.4%	0.35	-2.35
(t_{L-S})	(-3.25)	(-2.95)	(-2.87)	(-0.1)	(3.84)	(-4.31)	**(t_{L-S})**	(-3.53)	(-2.58)	(-2.77)	(-0.5)	(2.16)	(-3.45)

Table 8
Performance of Duration Portfolios Based on *DSS Dur*

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on *DSS Dur*, which is measured from equation 16 (empirical details in Section 4.2), and monthly portfolio returns span the subsequent twelve months (from July/1973 to June/2017). Panel A shows average returns ($\times 12$), volatilities ($\times\sqrt{12}$), and Sharpe Ratios ($\times\sqrt{12}$). Panel B reports αs ($\times 12$) and βs from factor regressions. Statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)) with t_{stat} in parentheses and p-value in brackets.

PANEL A: Average Returns, Volatilities, and Sharpe Ratios

Duration Decile	Value-Weighted Portfolios $\overline{r}_{t\to t+1}$	$\overline{r}_{t\to t+5}$	$\overline{r}_{t+4\to t+5}$	$\overline{r}^{Large}_{t\to t+1}$	σ	$\overline{r}/\sigma$	Duration Decile	Equal-Weighted Portfolios $\overline{r}_{t\to t+1}$	$\overline{r}_{t\to t+5}$	$\overline{r}_{t+4\to t+5}$	$\overline{r}^{Large}_{t\to t+1}$	σ	$\overline{r}/\sigma$
Short	11.9%	11.3%	9.9%	9.6%	20.1%	0.59	**Short**	12.6%	12.2%	11.0%	10.6%	21.7%	0.58
2	10.2%	9.9%	9.2%	8.6%	17.5%	0.58	**2**	12.2%	12.0%	12.0%	9.5%	19.6%	0.62
3	10.6%	9.4%	10.2%	7.9%	17.6%	0.60	**3**	11.7%	12.0%	12.2%	9.8%	19.3%	0.61
4	10.3%	9.6%	8.8%	8.0%	17.0%	0.60	**4**	11.8%	11.8%	10.9%	9.4%	18.9%	0.62
5	8.4%	9.3%	9.3%	7.7%	16.8%	0.50	**5**	11.4%	11.4%	11.7%	8.6%	18.9%	0.60
6	9.4%	8.8%	8.7%	7.7%	16.0%	0.59	**6**	11.0%	11.3%	11.2%	8.9%	19.6%	0.56
7	9.2%	8.9%	9.2%	6.7%	17.0%	0.54	**7**	10.3%	10.6%	10.1%	7.5%	19.5%	0.53
8	7.5%	7.5%	7.2%	6.1%	16.1%	0.47	**8**	9.0%	9.4%	9.7%	6.9%	20.7%	0.44
9	7.1%	6.7%	7.6%	5.5%	16.7%	0.42	**9**	7.1%	8.8%	10.4%	6.3%	23.1%	0.31
Long	5.3%	6.0%	8.2%	4.9%	20.6%	0.26	**Long**	4.5%	7.1%	8.3%	4.9%	28.0%	0.16
L-S	-6.6%	-5.3%	-1.8%	-4.8%	16.6%	-0.40	**L-S**	-8.1%	-5.1%	-2.7%	-5.7%	16.5%	-0.49
(t_{L-S})	(-2.10)	(-2.01)	(-0.59)	(-1.41)	[0.07]	[0.01]	**(t_{L-S})**	(-2.74)	(-2.09)	(-1.01)	(-2.01)	[0.00]	[0.00]

PANEL B: Risk-Adjusted Performance Based on Factor Models

Duration Decile	CAPM α_{CAPM}	β_{MKT}	Fama and French (2015) **5-Factors** α_{FF}	β_{MKT}	β_{SMB}	β_{HML}	β_{CMA}	β_{RMW}	Hou, Xue, and Zhang (2015) **q-Factors** α_q	β_{MKT}	β_{SIZE}	β_{INV}	β_{ROE}
Value-Weighted Portfolios													
Short	3.9%	1.04	-0.1%	1.08	0.42	0.67	-0.14	0.09	2.9%	1.04	0.30	0.50	-0.30
2	3.2%	0.95	-1.0%	1.04	0.21	0.47	0.02	0.27	0.6%	1.01	0.12	0.50	-0.03
3	3.5%	0.98	-0.5%	1.05	0.29	0.40	0.02	0.28	1.1%	1.02	0.18	0.45	-0.04
4	3.4%	0.96	-0.2%	1.04	0.17	0.26	0.17	0.21	1.5%	1.00	0.08	0.42	-0.06
5	2.0%	0.93	-1.6%	1.02	0.12	0.19	0.21	0.29	-0.5%	0.99	0.04	0.40	0.04
6	3.1%	0.90	-0.1%	1.00	0.03	-0.01	0.35	0.32	-0.3%	0.98	0.00	0.35	0.20
7	2.4%	0.98	-0.5%	1.05	0.08	-0.02	0.22	0.39	-0.4%	1.03	0.02	0.23	0.21
8	0.7%	0.94	-0.8%	0.99	0.02	-0.18	0.30	0.20	-1.0%	0.97	0.02	0.07	0.18
9	0.2%	0.98	-0.4%	1.01	-0.06	-0.34	0.19	0.33	-0.7%	1.00	-0.07	-0.16	0.29
Long	-3.1%	1.21	-0.2%	1.09	0.05	-0.46	-0.14	0.00	0.0%	1.12	0.01	-0.61	0.06
L-S	-7.0%	0.17	-0.1%	0.01	-0.37	-1.12	0.00	-0.09	-3.0%	0.08	-0.29	-1.11	0.36
(t_{L-S})	(-2.02)	(1.67)	(-0.04)	(0.20)	(-4.95)	(-10.17)	(0.02)	(-0.82)	(-0.93)	(1.16)	(-2.56)	(-5.23)	(2.12)
Equal-Weighted Portfolios													
Short	4.2%	1.12	-1.8%	1.16	0.80	0.67	-0.04	0.23	1.3%	1.10	0.63	0.68	-0.29
2	4.3%	1.07	-1.0%	1.10	0.71	0.45	0.06	0.27	1.1%	1.05	0.58	0.52	-0.13
3	3.9%	1.07	-1.4%	1.10	0.68	0.36	0.12	0.31	0.6%	1.05	0.56	0.47	-0.07
4	4.2%	1.06	-0.4%	1.08	0.63	0.27	0.08	0.32	1.0%	1.04	0.52	0.36	0.00
5	3.6%	1.08	-0.2%	1.08	0.59	0.20	0.04	0.29	1.0%	1.05	0.49	0.24	0.01
6	3.0%	1.12	0.1%	1.10	0.58	0.08	0.07	0.22	1.3%	1.07	0.49	0.13	0.00
7	2.1%	1.13	0.8%	1.06	0.55	0.00	-0.03	0.06	2.1%	1.04	0.48	-0.10	-0.08
8	0.4%	1.19	0.3%	1.09	0.51	-0.13	-0.11	0.06	1.5%	1.08	0.43	-0.30	-0.05
9	-2.5%	1.33	0.0%	1.14	0.51	-0.38	-0.13	-0.21	1.0%	1.15	0.46	-0.60	-0.16
Long	-6.6%	1.53	-3.3%	1.28	0.74	-0.33	-0.12	-0.55	-0.6%	1.30	0.64	-0.54	-0.57
L-S	-10.7%	0.41	-1.5%	0.12	-0.06	-1.00	-0.08	-0.78	-1.9%	0.19	0.01	-1.22	-0.27
(t_{L-S})	(-3.24)	(3.63)	(-0.96)	(3.03)	(-0.90)	(-12.45)	(-0.58)	(-5.91)	(-0.65)	(2.28)	(0.05)	(-5.00)	(-1.09)

Internet Appendix

"The Short Duration Premium"

By Andrei S. Gonçalves

This Internet Appendix is organized as follows. Section A contains technical derivations required to support the results in the paper, Section B details data sources and measurement for the analysis, Section C explains how I estimate the ICAPM, and Section D describes some further results that supplement the main findings in the paper.

A Technical Derivations

A.1 Using VAR to get $\mathbb{E}_t[PO_{t+h}]/BE_t$

From equation 3 and the conditional normality imposed by the VAR process in equation 4, we have:

$$\begin{aligned}
\frac{\mathbb{E}_t\left[PO_{t+h}\right]}{BE_t} &= \mathbb{E}_t\left[\left(e^{CSprof_{t+h}-BEg_{t+h}+\sum_{\tau=1}^{h}BEg_{t+\tau}} - e^{\sum_{\tau=1}^{h}BEg_{t+\tau}}\right)\right] \\
&= e^{\mathbb{E}_t\left[CSprof_{t+h}-BEg_{t+h}+\sum_{\tau=1}^{h}BEg_{t+\tau}\right]+0.5\cdot Var_t\left[CSprof_{t+h}-BEg_{t+h}+\sum_{\tau=1}^{h}BEg_{t+\tau}\right]} \\
&\quad - e^{\mathbb{E}_t\left[\sum_{\tau=1}^{h}BEg_{t+\tau}\right]+0.5\cdot Var_t\left[\sum_{\tau=1}^{h}BEg_{t+\tau}\right]} \\
&= \left(e^{\mathbb{E}_t\left[CSprof_{t+h}-BEg_{t+h}\right]+0.5\cdot Var_t\left[CSprof_{t+h}-BEg_{t+h}\right]+Cov_t\left[CSprof_{t+h}-BEg_{t+h},\sum_{\tau=1}^{h}BEg_{t+\tau}\right]} - 1\right) \\
&\quad \times e^{\mathbb{E}_t\left[\sum_{\tau=1}^{h}BEg_{t+\tau}\right]+0.5\cdot Var_t\left[\sum_{\tau=1}^{h}BEg_{t+\tau}\right]} \\
&= \left[e^{(\mathbf{1}_{CSprof}-\mathbf{1}_{BEg})'\Gamma^h s_t+v_1(h)} - 1\right]\cdot e^{\mathbf{1}'_{BEg}\left(\sum_{\tau=1}^{h}\Gamma^\tau\right)\cdot s_t+h\cdot v_2(h)}
\end{aligned}$$

which is equation 5 in subsection 1.1 with:

$$v_1(h) \;=\; 0.5\cdot Var_t\left[CSprof_{t+h}-BEg_{t+h}\right] + Cov_t\left[CSprof_{t+h}-BEg_{t+h},\sum_{\tau=1}^{h}BEg_{t+\tau}\right]$$

and

$$h\cdot v_2(h) = 0.5\cdot Var_t\left[\sum_{\tau=1}^{h}BEg_{t+\tau}\right] = 0.5\cdot Cov_t\left[\sum_{\tau=1}^{h}BEg_{t+\tau},\sum_{\tau=1}^{h}BEg_{t+\tau}\right]$$

a) Deriving $v_1(h)$

Define $po = CSprof - BEg$ and $\mathbf{1}_{po} = \mathbf{1}_{CSprof} - \mathbf{1}_{BEg}$. Then, from the VAR structure, it is straightforward to get:

$$Var_t\left[CSprof_{t+h}-BEg_{t+h}\right] = Var_t\left[CSprof_{t+h-1}-BEg_{t+h-1}\right] + \mathbf{1}'_{po}\Gamma^{h-1}\Sigma\Gamma'^{h-1}\mathbf{1}_{po} \qquad \text{(IA.1)}$$

with boundary condition $Var_t\left[CSprof_{t+1}-BEg_{t+1}\right] = \mathbf{1}'_{po}\Sigma\mathbf{1}_{po}$.

For the other term in $v_1(h)$, which I label $Cov_1(h)$ for simplicity, we have $Cov_1(1) = Cov_t[po_{t+1}, bg_{t+1}] = \mathbf{1}'_{po}\Sigma\mathbf{1}_{BEg}$ and then:

$$
\begin{aligned}
Cov_1\left(2\right) &= Cov_t\left[po_{t+2}, BEg_{t+1} + BEg_{t+2}\right] \\
&= \theta \cdot Cov_t\left[po_{t+2}, BEg_{t+1}\right] + Cov_t\left[po_{t+2}, BEg_{t+2}\right] \\
&= \theta \cdot Cov_t\left[\mathbf{1}_{po}^{'}(\Gamma u_{t+1} + u_{t+2}), \mathbf{1}_{BEg}^{'} u_{t+1}\right] + Cov_t\left[\mathbf{1}_{po}^{'}(\Gamma u_{t+1} + u_{t+2}), \mathbf{1}_{BEg}^{'}(\Gamma u_{t+1} + u_{t+2})\right] \\
&= \theta \cdot \mathbf{1}_{po}^{'}\Gamma\Sigma\mathbf{1}_{BEg} + \mathbf{1}_{po}^{'}\Gamma\Sigma\Gamma^{'}\mathbf{1}_{BEg} + \mathbf{1}_{po}^{'}\Sigma\mathbf{1}_{BEg} \\
&= \mathbf{1}_{po}^{'}\Gamma\Sigma(\Gamma + \theta \cdot \mathrm{I})^{'}\mathbf{1}_{BEg} + Cov_1\left(1\right)
\end{aligned}
$$

and

$$
\begin{aligned}
Cov_1\left(3\right) &= Cov_t\left[po_{t+3}, BEg_{t+1} + BEg_{t+2} + BEg_{t+3}\right] \\
&= \theta^2 \cdot Cov_t\left[po_{t+3}, BEg_{t+1}\right] + \theta \cdot Cov_t\left[po_{t+3}, BEg_{t+2}\right] + Cov_t\left[po_{t+3}, BEg_{t+3}\right] \\
&= \theta^2 \cdot Cov_t\left[\mathbf{1}_{po}^{'}(\Gamma^2 u_{t+1} + \Gamma u_{t+2} + u_{t+3}), \mathbf{1}_{BEg}^{'} u_{t+1}\right] \\
&\quad + \theta \cdot Cov_t\left[\mathbf{1}_{po}^{'}(\Gamma^2 u_{t+1} + \Gamma u_{t+2} + u_{t+3}), \mathbf{1}_{BEg}^{'}(\Gamma u_{t+1} + u_{t+2})\right] \\
&\quad + Cov_t\left[\mathbf{1}_{po}^{'}(\Gamma^2 u_{t+1} + \Gamma u_{t+2} + u_{t+3}), \mathbf{1}_{BEg}^{'}(\Gamma^2 u_{t+1} + \Gamma u_{t+2} + u_{t+3})\right] \\
&= \mathbf{1}_{po}^{'}\Gamma^2\Sigma(\Gamma^2 + \theta \cdot \Gamma + \theta^2 \cdot \mathrm{I})^{'}\mathbf{1}_{BEg} + \mathbf{1}_{po}^{'}\Gamma\Sigma(\Gamma + \theta \cdot \mathrm{I})^{'}\mathbf{1}_{BEg} + \mathbf{1}_{po}^{'}\Sigma\mathbf{1}_{BEg} \\
&= \mathbf{1}_{po}^{'}\Gamma^2\Sigma(\Gamma^2 + \theta \cdot \Gamma + \theta^2 \cdot \mathrm{I})^{'}\mathbf{1}_{BEg} + Cov_1\left(2\right)
\end{aligned}
$$

which generalizes to:

$$
Cov_1\left(h\right) = \mathbf{1}_{po}^{'}\Gamma^{h-1}\Sigma F(h)^{'}\mathbf{1}_{BEg} + Cov_1\left(h-1\right) \tag{IA.2}
$$

where $F(h) = F(h-1)\Gamma + \mathrm{I} \cdot \theta^{h-1}$ with I representing an identity matrix and θ capturing a scalar shrinkage factor I introduce (see below).

Putting all terms together, we have:

$$
v_1(h) = v_1(h-1) + 0.5 \cdot \mathbf{1}_{po}^{'}\Gamma^{h-1}\Sigma\Gamma^{'h-1}\mathbf{1}_{po} + \mathbf{1}_{po}^{'}\Gamma^{h-1}\Sigma F(h)^{'}\mathbf{1}_{BEg} \tag{IA.3}
$$

with boundary condition $v_1(1) = 0.5 \cdot \mathbf{1}_{po}^{'}\Sigma\mathbf{1}_{po} + \mathbf{1}_{po}^{'}\Sigma\mathbf{1}_{BEg}$.

The VAR imposes $\theta = 1$. However, the VAR implied covariance between variables with a significant number of lags between them can be very noisy because a small estimation error in Σ can induce a substantial estimation error in such covariance. To deal with this issue, I introduce a shrinkage factor $\theta < 1$ that shrinks the covariance toward zero and receives an exponent of the same size as the lag difference between variables (e.g., θ^{10} is applied to the covariance between po_{t+11} and BEg_{t+1}). Since the state vector is stationary, the covariance has to go to zero as the number of lags between the variables increases. The shrinkage factor simply speeds up this convergence and induces no relevant cross-sectional effects since $v_1(h)$ and $v_2(h)$ are the same for all firms. In fact, results are very similar without the shrinkage factor (i.e., with $\theta = 1$) with the exception that I cannot numerically find dr for some firm/year observations. The reason is that, for some combinations of Γ, Σ, and s_t, the $v_1(h)$ and $v_2(h)$ components dominate the behavior of the valuation equation and induce numerical difficulties in the root-finding algorithm. The shrinkage factor (chosen to keep less than 10% of the covariances between variables with more than ten years between then: $\theta^{10} = 0.1$) solves all numerical problems encountered.[31]

b) Deriving $v_2(h)$

Letting $Cov_t\left(BEg_{t+\tau}, BEg_{t+h}\right) = Cov_{\tau,h}^{BEg}$, we have $1 \cdot v_2(1) = 0.5 \cdot Cov_{1,1}^{BEg}$ and then:

$$\begin{aligned} 2 \cdot v_2\left(2\right) &= 0.5 \cdot Cov_t\left[BEg_{t+1} + BEg_{t+2}, BEg_{t+1} + BEg_{t+2}\right] \\ &= 0.5 \cdot (Cov_{1,1}^{BEg} + Cov_{2,2}^{BEg}) + \theta \cdot Cov_{1,2}^{BEg} \end{aligned}$$

and

$$\begin{aligned} 3 \cdot v_2\left(3\right) &= 0.5 \cdot Cov_t\left[BEg_{t+1} + BEg_{t+2} + BEg_{t+3}, BEg_{t+1} + BEg_{t+2} + BEg_{t+3}\right] \\ &= 0.5 \cdot (Cov_{1,1}^{BEg} + Cov_{2,2}^{BEg} + Cov_{3,3}^{BEg}) + \left[\theta \cdot Cov_{1,2}^{BEg} + \theta \cdot Cov_{2,3}^{BEg} + \theta^2 \cdot Cov_{1,3}^{BEg}\right] \end{aligned}$$

which generalizes to:

[31] I find almost identical results without numerical issues when imposing $\mathbb{E}_t[\left(e^{CSprof_{t+h} - BEg_{t+h}} - 1\right) \cdot e^{\sum_{\tau=1}^{h} BEg_{t+\tau}}] = \mathbb{E}_t[\left(e^{CSprof_{t+h} - BEg_{t+h}} - 1\right)] \cdot \mathbb{E}_t[e^{\sum_{\tau=1}^{h} BEg_{t+\tau}}]$, which is very similar to the approach in Dechow, Sloan, and Soliman (2004). The main results are also similar with the log-linear duration measure introduced in subsection 4.1, which does not require a shrinkage factor as it does not depend on any covariance term.

$$h \cdot v_2(h) = (h-1) \cdot v_2(h-1) + 0.5 \cdot Cov_{h,h}^{BEg} + \sum_{i=1}^{h-1} \theta^i \cdot Cov_{h-i,h}^{BEg} \tag{IA.4}$$

with boundary condition $v_2(1) = 0.5 \cdot Cov_{1,1}^{BEg}$

Hence, all we need is an expression for $Cov_{\tau,h}^{BEg}$ with $\tau = 1, 2, ..., h$. However, note that $BEg_{t+h} = u_{t+h} + \Gamma u_{t+h-1} + \Gamma^2 u_{t+h-2} + ... + \Gamma^{h-1} u_{t+1} + \Gamma^h s_t$, and thus:

$$\begin{aligned} Cov_{\tau,h}^{BEg} &= Cov_t\left(u_{t+\tau} + \Gamma u_{t+\tau-1} + ... + \Gamma^{\tau-1} u_{t+1}, u_{t+h} + \Gamma u_{t+h-1} + \Gamma^2 u_{t+h-2} + ... + \Gamma^{h-1} u_{t+1}\right) \\ &= Cov_t\left(u_{t+\tau} + \Gamma u_{t+\tau-1} + ... + \Gamma^{\tau-1} u_{t+1}, \Gamma^{h-\tau} u_{t+\tau} + \Gamma^{h-\tau+1} u_{t+\tau-1} + ... + \Gamma^{h-1} u_{t+1}\right) \\ &= \mathbf{1}_{BEg}' \left[I\Sigma\Gamma'^{h-\tau} + \Gamma\Sigma\Gamma'^{h-\tau+1} + \Gamma^2\Sigma\Gamma'^{h-\tau+2} + ... + \Gamma^{\tau-1}\Sigma\Gamma'^{h-1} \right] \mathbf{1}_{BEg} \end{aligned} \tag{IA.5}$$

which concludes the derivation of $v_2(h)$.

A.2 Infinite Sums

While in principle the valuation identity in Equation 6 accounts for the present value of cash flows going to infinity, in practice (numerically) we need some approximation to deal with very long-term cash flows. I assume that cash flow growth already reached its limiting behavior at a maturity of $H = 1,000$ years. This means that (for $h \geq H$):

$$\frac{e^{-(h+1)\cdot dr_{i,t}} \cdot \mathbb{E}_t\left[PO_{i,t+h+1}\right] / BE_{i,t}}{e^{-h\cdot dr_{i,t}} \cdot \mathbb{E}_t\left[PO_{i,t+h}\right] / BE_{i,t}} = e^{\overline{BEg} + \overline{v}_2 - dr_{i,t}} \tag{IA.6}$$

so that we can split the valuation equation into two terms:

$$\begin{aligned} \frac{ME_{i,t}}{BE_{i,t}} &= \left(\sum_{h=1}^{H} \mathbb{E}_t\left[PO_{i,t+h}/BE_{i,t}\right] \cdot e^{-h\cdot dr_{i,t}}\right) + \left(\sum_{h=H+1}^{\infty} \mathbb{E}_t\left[PO_{i,t+h}/BE_{i,t}\right] \cdot e^{-h\cdot dr_{i,t}}\right) \\ &= \left(\sum_{h=1}^{H} \mathbb{E}_t\left[PO_{i,t+h}/BE_{i,t}\right] \cdot e^{-h\cdot dr_{i,t}}\right) + \mathbb{E}_t\left[PO_{i,t+H}/BE_{i,t}\right] \cdot e^{-H\cdot dr_{i,t}} \cdot \sum_{h=1}^{\infty} e^{h\cdot(\overline{BEg} + \overline{v}_2 - dr_{i,t})} \\ &= \left(\sum_{h=1}^{H} \mathbb{E}_t\left[PO_{i,t+h}/BE_{i,t}\right] \cdot e^{-h\cdot dr_{i,t}}\right) + \mathbb{E}_t\left[PO_{i,t+H}/BE_{i,t}\right] \cdot e^{-H\cdot dr_{i,t}} \cdot \overline{PV_{i,t}/CF_{i,t}} \end{aligned}$$

where $\overline{PV_{i,t}/CF_{i,t}} = e^{\overline{BEg}+\overline{v}_2-dr_{i,t}}/(1-e^{\overline{BEg}+\overline{v}_2-dr_{i,t}})$, with $\overline{BEg}$ representing the steady-state growth in (log) book-equity (obtained from the VAR) and $\overline{v}_2$ reflecting $v_2(\infty)$, which we approximate as $v_2(H)$.

Similarly, when calculating equity duration, I relied on:

$$\begin{aligned} Dur_{i,t} &= \left(\sum_{h=1}^{H} w_{i,t}^{(h)} \cdot h\right) + \left(\sum_{h=H+1}^{\infty} w_{i,t}^{(h)} \cdot h\right) \\ &= \left(\sum_{h=1}^{H} w_{i,t}^{(h)} \cdot h\right) + H \cdot \left(1-\sum_{h=1}^{H} w_{i,t}^{(h)}\right) + w_{i,t}^{(H)} \cdot \sum_{h=1}^{\infty} h \cdot e^{h\cdot(\overline{BEg}+\overline{v}_2-dr_{i,t})} \\ &= \left(\sum_{h=1}^{H} w_{i,t}^{(h)} \cdot h\right) + H \cdot \left(1-\sum_{h=1}^{H} w_{i,t}^{(h)}\right) + w_{i,t}^{(H)} \cdot \overline{Dur_{i,t}/w_{i,t}} \end{aligned}$$

where $\overline{Dur_{i,t}/w_{i,t}} = e^{\overline{BEg}+\overline{v}_2-dr_{i,t}}/(1-e^{\overline{BEg}+\overline{v}_2-dr_{i,t}})^2$ and $w_{i,t}^{(h)} = \mathbb{E}_t\left[PO_{i,t+h}/BE_{i,t}\right] \cdot e^{-h\cdot dr_{i,t}}/(ME_{i,t}/BE_{i,t})$.

A.3 Deriving $llDur$

Consider the following first order (bivariate) Taylor expansion around $\mathbb{E}_t[mb_{t+h}]$ and $\mathbb{E}_t[CSprof_{t+h} - BEg_{t+h}]$:

$$ln\left(e^{mb_{t+h}} + e^{CSprof_{t+h}-BEg_{t+h}} - 1\right) \approx k_{1,t}^{(h)} + k_{2,t}^{(h)} \cdot mb_{t+h} + k_{3,t}^{(h)} \cdot (CSprof_{t+h} - BEg_{t+h}) \quad \text{(IA.7)}$$

with:

$$\begin{aligned} k_{1,t}^{(h)} &= ln\left(e^{\mathbb{E}_t[mb_{t+h}]} + e^{\mathbb{E}_t[CSprof_{t+h}-BEg_{t+h}]} - 1\right) - \left\{k_{2,t}^{(h)} \cdot \mathbb{E}_t[mb_{t+h}] + k_{3,t}^{(h)} \cdot \mathbb{E}_t[CSprof_{t+h} - BEg_{t+h}]\right\} \\ k_{2,t}^{(h)} &= e^{\mathbb{E}_t[mb_{t+h}]}/(e^{\mathbb{E}_t[mb_{t+h}]} + e^{\mathbb{E}_t[CSprof_{t+h}-BEg_{t+h}]} - 1) \\ k_{3,t}^{(h)} &= e^{\mathbb{E}_t[CSprof_{t+h}-BEg_{t+h}]}/(e^{\mathbb{E}_t[mb_{t+h}]} + e^{\mathbb{E}_t[CSprof_{t+h}-BEg_{t+h}]} - 1) \end{aligned}$$

Now, note that gross stock returns are given by:

$$\begin{aligned} R_{t+1} &= (P_{t+1} + D_{t+1})/P_t \\ &= (N_{t+1} \cdot P_{t+1} + N_t \cdot D_{t+1} - \Delta N_{t+1} P_{t+1})/(N_t \cdot P_t) \\ &= (ME_{t+1} + PO_{t+1})/ME_t \end{aligned} \quad \text{(IA.8)}$$

Then, using the definition of clean surplus earnings, $CSE_t = PO_t + \Delta BE_t$, we can get:

$$R_{t+1} = \frac{BE_{t+1}}{BE_t}\left[\frac{ME_{t+1}}{BE_{t+1}} + \left(\frac{CSE_{t+1}}{BE_t} + 1\right) \cdot \left(\frac{BE_{t+1}}{BE_t}\right)^{-1} - 1\right] \Big/ \frac{ME_t}{BE_t} \tag{IA.9}$$

which in logs becomes:

$$r_{t+1} = BEg_{t+1} + ln\left(e^{mb_{t+1}} + e^{CSprof_{t+1} - BEg_{t+1}} - 1\right) - mb_t \tag{IA.10}$$

$$\Downarrow$$

$$mb_t \approx k_{1,t}^{(1)} + k_{3,t}^{(1)} \cdot CSprof_{t+1} + [1 - k_{3,t}^{(1)}] \cdot BEg_{t+1} - r_{t+1} + k_{2,t}^{(1)} \cdot mb_{t+1} \tag{IA.11}$$

where the approximation follows from the Taylor expansion in IA.7.

For mb_{t+1}, we can use the Taylor expansion on $ln\left(e^{mb_{t+2}} + e^{CSprof_{t+2} - BEg_{t+2}} - 1\right)$ to get:

$$\begin{aligned} mb_t \approx\ & k_{1,t}^{(1)} + k_{2,t}^{(1)} \cdot k_{1,t}^{(2)} \\ & + \left(k_{3,t}^{(1)} \cdot CSprof_{t+1} + [1 - k_{3,t}^{(1)}] \cdot BEg_{t+1}\right) + k_{2,t}^{(1)} \cdot \left(k_{3,t}^{(2)} \cdot CSprof_{t+2} + [1 - k_{3,t}^{(2)}] \cdot BEg_{t+2}\right) \\ & - \left(r_{t+1} + k_{2,t}^{(1)} r_{t+2}\right) + k_{2,t}^{(1)} \cdot k_{2,t}^{(2)} \cdot mb_{t+2} \end{aligned} \tag{IA.12}$$

and apply recursive substitution to obtain:

$$\begin{aligned} mb_t \approx\ & \sum_{h=1}^{\infty}\left(\prod_{\tau=0}^{h-1} k_{2,t}^{(\tau)}\right) \cdot k_{1,t}^{(h)} \\ & + \sum_{h=1}^{\infty}\left(\prod_{\tau=0}^{h-1} k_{2,t}^{(\tau)}\right) \cdot \left(k_{3,t}^{(h)} \cdot CSprof_{t+h} + [1 - k_{3,t}^{(h)}] \cdot BEg_{t+h}\right) \\ & - \sum_{h=1}^{\infty}\left(\prod_{\tau=0}^{h-1} k_{2,t}^{(\tau)}\right) \cdot r_{t+h} + \lim_{h\to\infty}\left(\prod_{\tau=0}^{h-1} k_{2,t}^{(\tau)}\right) \cdot mb_{t+h} \end{aligned} \tag{IA.13}$$

Then, taking expectation and applying the transversality (no rational bubble) condition, we have:

$$
\begin{aligned}
mb_t \approx\ & \sum_{h=1}^{\infty}\left(\prod_{\tau=0}^{h-1} k_{2,t}^{(\tau)}\right)\cdot k_{1,t}^{(h)} \\
& + \sum_{h=1}^{\infty}\left(\prod_{\tau=0}^{h-1} k_{2,t}^{(\tau)}\right)\cdot \left(k_{3,t}^{(h)}\cdot \mathbb{E}_t[CSprof_{t+h}] + [1-k_{3,t}^{(h)}]\cdot \mathbb{E}_t[BEg_{t+h}]\right) \\
& - \sum_{h=1}^{\infty}\left(\prod_{\tau=0}^{h-1} k_{2,t}^{(\tau)}\right)\cdot \mathbb{E}_t[r_{t+h}]
\end{aligned} \tag{IA.14}
$$

which implies $llDur_t = -\partial ln(ME_t)/\partial dr_t = \sum_{h=1}^{\infty}\left(\prod_{\tau=0}^{h-1} k_{2,t}^{(\tau)}\right)$ after replacing all $\mathbb{E}_t[r_{t+h}]$ components by dr_t as done when defining equity duration in general.

In terms of the log-linear valuation equation, note that if we had approximated around the unconditional mean, then we would recover:

$$
\begin{aligned}
mb_t \approx\ & k_1/(1-k_2) \\
& + \sum_{h=1}^{\infty} k_2^{h-1}\cdot (k_3\cdot \mathbb{E}_t[CSprof_{t+h}] + [1-k_3]\cdot \mathbb{E}_t[BEg_{t+h}]) \\
& - \sum_{h=1}^{\infty} k_2^{h-1}\cdot \mathbb{E}_t[r_{t+h}]
\end{aligned} \tag{IA.15}
$$

which is a generalization of the approximation in Vuolteenaho (2002). In his case, $k_3 = 1$ (expected growth is irrelevant) because the approximation is around $ME/BE = 1$ or $mb = 0$.

This unconditional log-linear approximation has an equity duration that is constant across firms and over time: $\sum_{h=1}^{\infty} k_2^{h-1}$. Hence, this approximation is not useful for the purpose of this paper. I adjust it by changing the expansion point to incorporate firm- and time-specific information so that $llDur_t = \sum_{h=1}^{\infty}\left(\prod_{\tau=0}^{h-1} k_{2,t}^{(\tau)}\right)$ varies across firms and over time.

B Data Sources and Measurement

B.1 Constructing Returns on the Short-term Dividend Claim

Figures 1(c) and 4(c) use a short duration asset, which I proxy for with a S&P500 dividend claim with maturity between 1 and 2 years. This subsection describes the construction of this dividend claim.

I obtain daily prices on S&P500 dividend futures from two sources: (i) a proprietary dataset of over-the-counter quoted prices for dividend futures (from 03-Jan-2005 to 14-Oct-2016) that Goldman Sachs uses firm-wide both as a pricing source and to mark the internal trading books to the market and (ii) Bloomberg (from 15-Oct-2016 to 30-June-2017).[32]

To get dividend futures monthly prices, $F_{d,t}^{(h)}$, I use the last trading day of each month as the end of month price except that I use the quoted price as of the first trading day of 2005 as the end of month price for Dec-2004.

Dividend futures mature every December so that to obtain constant-maturity dividend futures prices at the monthly frequency I follow Binsbergen et al. (2013) and linearly interpolate between the two closest maturities. For instance, to get $F_d^{(2)}$ at the end of July-2010, I interpolate between the contracts with maturities of 17 and 29 months (expiring in Dec-2011 and Dec-2012). I use this approach to get $F_{d,t}^{(h)}$ and $F_{d,t}^{(h-1/12)}$ with $h = 1$ and 2 years.

Following Binsbergen and Koijen (2017), I avoid using prices of contracts that are close to maturity because they trade infrequently. Consequently, the shortest constant maturity strip I construct has 1.25 years. For simplicity, I still refer to it as the 1-year contract and use notation with $h = 1$. Goldman's data does not include the contract that matures in Dec-2005, which is needed to get $F_t^{(1)}$ from Dec-2004 to Sept-2005. I use the Dec-2006 contract for $F_{d,t}^{(1)}$ over these first months so that the maturity of the contract effectively starts at 2 years (in Dec-2004) and declines to 1.25 years by Oct-2005.

I calculate prices of dividend claims, $P_{d,t}^{(h)}$ and $P_{d,t}^{(h-1/12)}$, using a non-arbitrage condition,

[32]I thank Christian Mueller-Glissmann at Goldman Sachs International for providing me with the proprietary over-the-counter the data.

$P_{d,t}^{(h)} = F_{d,t}^{(h)} \cdot e^{-h \cdot y_t^{(h)}}$, with zero coupon bond yields, $y_t^{(h)}$, obtained from the parameters of the Svensson (1994) fit to bond yields provided by the FED (see Gürkaynak, Sack, and Wright (2007)). I then calculate monthly returns by $R_{d,t}^{(h)} = P_{d,t}^{(h-1/12)} / P_{d,t-1/12}^{(h)}$ and form the short-maturity claim based on a equal-weighted portfolio of $R_{d,t}^{(1)}$ and $R_{d,t}^{(2)}$. To avoid potential illiquidity/microstructure issues, I follow the recommendation in Boguth et al. (2012) and use annual log returns on this short-maturity claim.

The entire procedure described above provides annual returns on the short-term dividend claim from December/2005 to June/2017. For the earlier period, I use monthly returns on a S&P500 dividend strategy (with average maturity of 1.6 years) based on S&P500 option contracts (data made available by Binsbergen, Brandt, and Koijen (2012)) to construct annual returns from June/1997 to November/2005. Combining the two periods, I have a full time series of annual returns from June/1997 to June/2017 (21 years), which I use to construct Figures 1(c) and 4(c).

B.2 Variables used to Measure Risk Factors

This subsection details the data sources and measurement for variables used in the estimation of the risk factors in Section 3. The final dataset is a multivariate time series of monthly observations in which flow variables have annual measurement; this dataset extends from Dec-1952 to Dec-2017.

(i) Equity Returns (r_e), Dividend Growth (Δd), and Dividend Yield (dp)

Equity returns (r_e) and dividend growth (Δd) are based on a value-weighted portfolio containing all common stocks available in the CRSP dataset and their measurement accounts for delistings (as the duration portfolios) and M&A paid in cash (as suggested in Allen and Michaely (2003)). I do not use the CRSP value-weighted index because it includes all issues listed on NYSE, NASDAQ and AMEX with, on average, 5.3% of the market capitalization in the index referring to non common stock issues (see Sabbatucci (2015)). Moreover, accounting delistings and M&A activity requires a "bottom-up" approach.

I construct returns based on a value-weighted equity portfolio. I start by selecting all common shares (share codes 10 and 11) listed on NYSE, NASDAQ or AMEX (exchange code 1, 2, and 3) and then calculate value-weighted cum- and ex-dividend monthly returns ($R^{cum}_{m,t}$ and $R^{ex}_{m,t}$).

I also construct a monthly "M&A yield" ($M\&Ay = M\&A_t/P_{t-1}$) at the aggregate level. Specifically, each month I sum all proceeds from distributions that can be classified as originating from an M&A paid in cash (distribution code between 3000 and 3400) across all firms that have lagged market equity available and I divide this value by the sum of the lagged market equity for these firms.

To get dividends that incorporate M&A activity, I first adjust aggregate ex-dividend monthly returns by $\widehat{R}^{ex}_{m,t} = R^{ex}_{m,t} - M\&Ay$ and calculate a normalized aggregate price series, $\widehat{P}_t$, by cumulating $\widehat{R}^{ex}_{m,t}$. I then calculate dividends from cum- and ex-dividend returns as is standard the literature (see Koijen and Nieuwerburgh (2011)), but relying on the adjusted ex-dividend return so that $\widehat{D}_{m,t} = \left(R^{cum}_{m,t} - \widehat{R}^{ex}_{m,t}\right) \cdot \widehat{P}_{t-1}$.[33]

The monthly series of annual dividends ($\widehat{D}_t$) is based on the sum of the monthly dividends ($\widehat{D}_{m,t}$) over the respective period. I sum the dividend as opposed to reinvesting them into the stock market to avoid introducing properties of returns into dividend growth (see Chen (2009) and Binsbergen and Koijen (2010)).

Dividend growth is given by $\Delta d = log(\widehat{D}_t/\widehat{D}_{t-12})$ and dividend yield by $dy = log(\hat{D}_t/\widehat{P}_t)$. To get annual returns that are consistent with the assumption of no dividend reinvestment, I use $r_{e,t} = log((\widehat{P}_t + \widehat{D}_t)/\widehat{P}_{t-12})$ as opposed to compounding $R^{cum}_{m,t}$ (but the return series is almost identical either way). Finally, I subtract annual (log) inflation from r_e and Δd using the CPI index to get real quantities.

[33] It is important to note that the somewhat natural approach of calculating M&A based on $\widehat{D}_{m,t} = (R^{cum}_{m,t} - R^{ex}_{m,t}) \cdot P_{t-1} + M\&Ay \cdot P_{t-1}$ in which P_t is constructed from by cumulating $R^{ex}_{m,t}$ is incorrect as it produces price and dividend series that are inconsistent with the cum return provided: $R^{cum}_{m,t} \neq (P_t + \widehat{D}_{m,t})/P_{t-1}$. The method I develop ensures that $R^{cum}_{m,t} = (\widehat{P}_t + \widehat{D}_{m,t})/\widehat{P}_{t-1}$, which is important because accounting for M&A activity in dividend payments should not affect the cum-dividend return delivered by equities. It simply affects the split between how much of that return comes from dividends and price appreciation.

Sabbatucci (2015) and Gonçalves (2018) both show that including M&A activity in the dividend measurement changes the dynamics of Δd and dy and helps alleviating non-stationarity concerns with dividend yield.

(ii) Aggregate Predictive Variables ($z_t = [dp \quad poy \quad ty \quad TS \quad CS \quad VS]$)

Sources and measurement for the dividend yield (dp) were detailed above. Following Boudoukh et al. (2007), aggregate equity payout yield is $poy_t = log(0.1 + e^{dp_t} - NI_t/ME_t)$. To get the annual aggregate net issuances yield, NI_t/ME_t, I first calculate monthly aggregate net issuances yield, $NI_{m,t}/ME_{m,t} = \Sigma_j(ME_{j,t} - ME_{j,t-1} \cdot R^{ex}_{j,t})/\Sigma_j ME_t$, based on firms that have $ME_{j,t}$, $ME_{j,t-1}$, and $R^{ex}_{j,t}$ available. Then, I get the normalized market equity series $\widehat{ME}_t = \widehat{P}_t \cdot N_t$, where the normalized aggregate number of shares outstanding, N_t, comes from dividing the cumulative $\Sigma_j ME_{j,t}/\Sigma_j ME_{j,t-1}$ by the cumulative $R^{ex}_{m,t}$. Finally, $NI_t/ME_t = [\Sigma_{\tau=t-11}^{\tau=t}\widehat{ME}_\tau \cdot (NI_{m,\tau}/ME_{m,\tau})]/\widehat{ME}_t$.

The treasury yield (ty) is the one year log Treasury yield and comes from CRSP Fama-Bliss discount bond file. The term spread (TS) is the difference between the ten year log Treasury yield and ty with the former coming from Global Financial Data until Mar-1953 and from the Federal Reserve of St. Louis website after that. The credit spread (CS) is the difference between Moody's corporate BAA and AAA log yields with both coming from the Federal Reserve of St. Louis website. The value spread is the difference between the log book-to-market ratios of the value and growth portfolios formed based on small stocks with an adjustment to account for within year movements in market equity. Data comes from Kenneth French's data library and the measurement follows Campbell and Vuolteenaho (2004).

C ICAPM Estimation and Inference

The relative risk premium between assets j and i in the ICAPM is given by:

$$\mathbb{E}\left[R_{j,t} - R_{i,t}\right] = \gamma \cdot Cov(r_{j,t} - r_{i,t}, \tilde{r}_{e,t}) \; + \; \lambda_{\mathbb{E}r} \cdot Cov(r_{j,t} - r_{i,t}, \widetilde{\mathbb{E}}_t r) \tag{IA.16}$$

$$\Downarrow$$

$$R_{j,t} - R_{i,t} = \gamma \cdot Cov(r_{j,t} - r_{i,t}, \tilde{r}_{e,t}) \; + \; \lambda_{\mathbb{E}r} \cdot Cov(r_{j,t} - r_{i,t}, \widetilde{\mathbb{E}}_t r) \; + \; \epsilon_{j,t} \tag{IA.17}$$

where $\lambda_{\mathbb{E}r} = (\gamma - 1) \cdot (1 - \phi_r^{H-1})/(1 - \phi_r)$, with γ, H, and ϕ_r representing relative risk aversion, investor's horizon, and expected return persistence.

The model is estimated using Equation IA.17 with different restrictions: $\gamma \geq 0$ and $\lambda_{\mathbb{E}r} = 0$ for the CAPM; $\gamma \geq 0$ and $0 \leq \lambda_{\mathbb{E}r}/(\gamma - 1) \leq (1 - \phi^{49})/(1 - \phi)$ for the ICAPM; and no restriction for the ICAPM$_{\text{U}}$.[34] However, the estimation method is identical (except for the restrictions imposed) in all three cases.

Specifically, I use as excess returns the spreads between each duration portfolio (from decile 2 to decile 10) relative to the shortest duration portfolio (decile 1) and estimate the covariances $Cov(r_{j,t} - r_{i,t}, \tilde{r}_{e,t})$ and $Cov(r_{j,t} - r_{i,t}, \widetilde{\mathbb{E}}_t r)$. I then estimate Equation IA.17 by regressing the respective excess returns on the covariances (which are fixed over time). To impose the relevant restrictions, I estimate risk prices using least squares with the respective equality and inequality restrictions (often called "order restricted linear regression"). Inference is done by repeating the estimation procedure for each cross-section to obtain a time-series of parameter estimates and then getting the covariance matrix of parameter estimates from Newey and West (1987, 1994) applied to this time-series. For specifications designed to match the equity premium, I also impose the constraint $\mathbb{E}[R_e - R_f] = \gamma \cdot Cov(r_{e,t} - r_{f,t}, \tilde{r}_{e,t}) \; + \; \lambda_{\mathbb{E}r} \cdot Cov(r_{e,t} - r_{f,t}, \widetilde{\mathbb{E}}_t r)$.

The entire estimation/inference procedure is identical to Fama and MacBeth (1973) (with

[34] For the ICAPM specification, I simplify the restrictions to keep the restriction set linear in γ and $\lambda_{\mathbb{E}r}$, which decreases the computational cost of estimating the model. Specifically, I impose $\gamma \geq 1$ (instead of $\gamma \geq 0$) because in this case the $0 \leq \lambda_{\mathbb{E}r}/(\gamma - 1) \leq (1 - \phi^{49})/(1 - \phi)$ restriction reduces to $0 \leq \lambda_{\mathbb{E}r} \leq (\gamma - 1) \cdot (1 - \phi^{49})/(1 - \phi)$. This adjustment has no effect on my results as the fully unconstrained model yield parameter estimates that are identical to the constrained one.

Newey and West (1987, 1994) standard errors) in the absence of parameter restrictions. However, parameter restrictions break the equivalence between pooled panel regressions and Fama and MacBeth (1973) cross-sectional regressions even when the restrictions do not bind for the final parameter estimates. This happens because restrictions can bind for specific cross-sections in the Fama and MacBeth (1973) procedure, which affects the final Fama and MacBeth (1973) estimates and standard errors. As such, I use panel regressions with coefficient restrictions as they are standard in the econometric literature. I still obtain standard errors using Fama and MacBeth (1973) because they are analogous to the typical bootstrap procedure used in the econometrics literature.

D Supplementary Empirical Results

This Section details a robustness analysis to the ICAPM results. Specifically, I reestimate the ICAPM that matches the equity premium and imposes $\gamma \geq 0$ and $0 \leq \lambda_{\mathbb{E}r}/(\gamma-1) \leq (1-\phi^{49})/(1-\phi)$ after changing several aspects of the baseline empirical specification. Results are provided in Table IA.4.

Column 1 changes the measurement of expected returns. In particular, the OLS estimation of $\mathbb{E}_t r = b' z_t$ (which is the baseline specification) does not use information on dividend growth predictability. However, Campbell-Shiller decomposition implies $B_r \cdot \mathbb{E}_t r = (dp_t - \overline{dp}) + B_g \cdot g_t$ where $B_g = 1/(1-\rho \cdot \phi_g)$ and $B_r = 1/(1-\rho \cdot \phi_r)$, and Chen and Zhao (2009) argue that it is important to account for both return and dividend growth predictability when estimating ICAPM risk factors. To address this issue, Column 1 shows that the baseline results are similar if we estimate $b_r' z_t$ and $b_g' z_t$ by projecting returns and dividend growth onto z_t (using OLS) and set $\mathbb{E}_t r$ to the average of $b_r' z_t$ and $[(dp_t - \overline{dp}) + B_g \cdot b_g' z_t]/B_r$.

Column 2 provides results that are similar to the baseline specification when dividends are measured without accounting for M&A paid in cash. However, the dividend yield in this case show signs of non-stationarity (see Sabbatucci (2015) and Gonçalves (2018)).

Columns 3 to 8 change the state variables used in $\mathbb{E}_t r = b' z_t$. Specifically, Columns 3 to 7 drop each of the state variables from the analysis (except for dp since the AR(1) specification for $\mathbb{E}_t r$ and g_t automatically implies dp is a state variable) and Column 8 adds dividend growth as a state variable. Alphas for the short duration premium are small and insignificant in all cases.

Columns 9 and 10 replace Dur with the two alternative duration measures, EPP and $llDur$, I explore in the main text. The ICAPM captures the short duration premium obtained from both of these equity duration measures.

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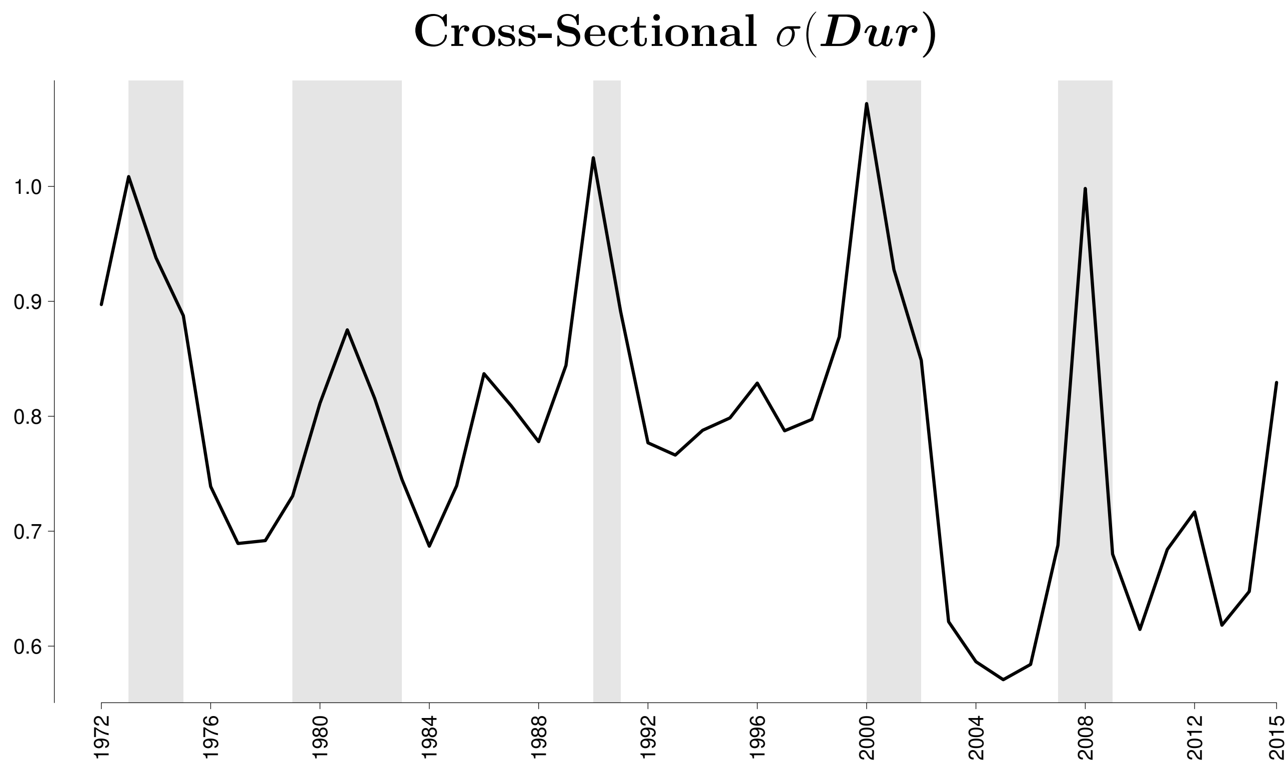

Figure IA.1
Time-Series of Cross-Sectional Dispersion in Duration

The graph reports the time variation in the cross-sectional standard deviation of $ln(Dur)$, with Dur measured from equation 7 (empirical details in Section 1). Specifically, for each year t, I select all firms with fiscal year ending in December (to align all accounting information) and measure the standard deviation of $ln(Dur_t)$ at that point in time. The logarithm transformation is used to decrease the large asymmetry in duration and the potential influence of outliers. Shaded regions represent recessionary periods (as defined by the National Bureau of Economic Research - NBER). I classify December of year t as being in a recessionary period if there is any recession from July of year t to June of year $t+1$.

Table IA.1
Rank Correlations Between Firm-level Characteristics

The table reports time series averages of cross-sectional rank correlations (Spearman's correlations) for the firm-level characteristics using the full sample of firms included in the duration portfolios. All variables are defined in Section 1.

	Dur	***Size***	***BE/M***	***PO/M***	***Y/M***	***BEg***	***Ag***	***Yg***	***CSprof***	***Roe***	***Gprof***	***Mlev***	***Blev***	***Cash***
Dur	1													
Size	0.21	1												
BE/M	-0.60	-0.38	1											
PO/M	-0.28	0.22	0.14	1										
Y/M	-0.44	-0.32	0.65	0.16	1									
BEg	0.07	0.24	-0.29	-0.30	-0.24	1								
Ag	0.15	0.24	-0.29	-0.18	-0.24	0.65	1							
Yg	0.17	0.16	-0.29	-0.19	-0.21	0.44	0.55	1						
CSprof	-0.02	0.39	-0.35	0.10	-0.21	0.80	0.55	0.38	1					
Roe	-0.08	0.43	-0.37	0.19	-0.16	0.64	0.45	0.32	0.85	1				
Gprof	-0.32	0.02	-0.24	0.06	0.08	0.23	0.20	0.16	0.34	0.39	1			
Mlev	0.02	-0.10	0.44	0.04	0.59	-0.19	-0.12	-0.12	-0.20	-0.21	-0.27	1		
Blev	0.25	0.02	0.12	-0.02	0.33	-0.09	-0.01	-0.01	-0.08	-0.10	-0.24	0.89	1	
Cash	-0.03	-0.03	-0.21	-0.09	-0.36	0.07	0.04	0.03	0.04	0.03	0.07	-0.53	-0.51	1

Table IA.2
Firm-Level Cross-Sectional Regressions

The table reports results from Fama and MacBeth (1973) cross-sectional regressions of stock returns on firm characteristics where all predictive variables are measured in log units and each cross-section is weighted based on the number of firms to avoid overweighting earlier observations (results are similar either way). I transform independent variables into z-scores and multiply coefficients by twelve to facilitate interpretation. This means that a coefficient of 1% implies that one cross-sectional standard deviation increase in the respective characteristic predicts a 1% higher average return on an annual basis. Columns 1.1 to 1.8 winsorize all independent variables at 1% and 99% while columns 2.1 to 2.8 also winsorize returns at the same levels. Statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)) with t_{stat} in parentheses.

Sorting	PANEL A - No Winsorization on Returns							
Variable	[1.1]	[1.2]	[1.3]	[1.4]	[1.5]	[1.6]	[1.7]	[1.8]
Dur	-4.4%	-3.5%	-4.4%	-4.1%	-3.9%		-3.1%	-2.9%
	(-6.29)	(-4.75)	(-6.23)	(-6.02)	(-4.88)		(-3.73)	(-3.81)
BE/M	3.4%	1.2%				3.7%	1.6%	0.9%
	(4.36)	(1.59)				(4.55)	(1.63)	(0.86)
Gprof	1.9%		0.4%			2.3%	0.8%	0.7%
	(3.56)		(0.78)			(4.36)	(1.32)	(1.17)
Ag	-3.1%			-2.4%				-2.1%
	(-5.61)			(-4.47)				(-4.61)
Size	-1.6%				-0.9%			-0.4%
	(-1.74)				(-0.96)			(-0.44)
Sorting	**PANEL B - Returns Winsorized at 1% and 99%**							
Variable	**[2.1]**	**[2.2]**	**[2.3]**	**[2.4]**	**[2.5]**	**[2.6]**	**[2.7]**	**[2.8]**
Dur	-4.3%	-3.9%	-4.3%	-4.1%	-4.1%		-3.7%	-3.2%
	(-6.55)	(-5.62)	(-6.35)	(-6.41)	(-5.46)		(-4.58)	(-4.47)
BE/M	2.9%	0.6%				3.1%	0.8%	0.8%
	(3.84)	(0.74)				(4.09)	(0.85)	(0.85)
Gprof	2.0%		0.5%			2.4%	0.5%	0.6%
	(4.11)		(1.04)			(4.76)	(0.88)	(1.13)
Ag	-2.4%			-1.7%				-1.6%
	(-4.62)			(-3.43)				(-3.81)
Size	-0.1%				0.6%			1.0%
	(-0.10)				(0.69)			(1.08)

Table IA.3
Correlations Between Shocks to Risk Factors and State Variables

The table reports correlations between shocks to risk factors and state variables. The risk factors are equity market realized returns (r_e) and expected returns ($\mathbb{E}r$). The state variables are the dividend yield (dp), equity payout yield (poy), one year Treasury yield (ty), term spread (TS), credit spread (CS), and value spread (VS). Measurement details are provided in Subsection 3.1.

	r_e	$\mathbb{E}r$	dp	poy	ty	TS	CS	VS
r_e	1							
$\mathbb{E}r$	-0.41	1						
dp	-0.55	0.46	1					
poy	-0.47	0.61	0.68	1				
ty	-0.15	-0.38	0.28	0.12	1			
TS	-0.06	0.59	-0.18	-0.02	-0.73	1		
CS	-0.41	0.29	0.30	0.15	-0.13	0.25	1	
VS	0.27	-0.56	-0.22	-0.38	-0.18	0.00	0.04	1

Table IA.4
ICAPM Estimation and Pricing Errors: Alternative Specifications

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on Dur, which is measured from equation 7 (empirical details in Section 1). The table reports risk prices and pricing errors (αs) for the estimation of Equation 13 using as testing assets excess returns of (value- and equal-weighted) duration portfolios relative to the shortest duration portfolio ($R_{Dur}^{(h)} - R_{Dur}^{(1)}$). The estimation further requires the model to perfectly match the equity premium, $\mathbb{E}[R_e - R_f]$, and satisfy the ICAPM pricing restrictions $\gamma \geq 0$ and $0 \leq \lambda_{\mathbb{E}r}/(\gamma - 1) \leq (1 - \phi^{49})/(1 - \phi)$. Each column changes one empirical decision relative to the baseline specification reported in the main text (see Section D for details). Subsection 3.1 explains the construction of risk factors and Section C provides details for the model estimation and inference. t_{stat} are in parentheses and statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)).

		$\mathbb{E}_t[\boldsymbol{R_e}]$ **w/ $\boldsymbol{\Delta d}$ Pred**	D_t **w/o $\boldsymbol{M\&A}$**	$\boldsymbol{s_t}$ **w/o $\boldsymbol{poy_t}$**	$\boldsymbol{s_t}$ **w/o $\boldsymbol{ty_t}$**	$\boldsymbol{s_t}$ **w/o $\boldsymbol{TS_t}$**	$\boldsymbol{s_t}$ **w/o $\boldsymbol{CS_t}$**	$\boldsymbol{s_t}$ **w/o $\boldsymbol{VS_t}$**	$\boldsymbol{s_t}$ **w/ $\boldsymbol{\Delta d_t}$**	**Dur = $\boldsymbol{EPP_t}$**	**Dur = $\boldsymbol{llDur_t}$**
	$\lambda_m = \gamma$	11.2	11.7	12.1	10.0	10.3	10.4	15.2	10.7	9.5	9.2
		(5.85)	(6.91)	(6.13)	(6.28)	(6.06)	(6.23)	(6.24)	(6.19)	(6.74)	(7.50)
	$\lambda_{\mathbb{E}r}$	38.7	28.0	34.0	25.1	26.9	25.4	64.9	24.2	20.1	19.2
		(4.10)	(4.75)	(4.36)	(4.04)	(4.01)	(4.08)	(4.87)	(4.09)	(4.16)	(4.54)
	implied H	6	4	5	4	4	4	7	4	4	4
	implied δ	0.87	0.75	0.83	0.81	0.82	0.80	0.91	0.78	0.77	0.76
	$\mathbb{E}[R_e - R_f]$	7.1%	7.2%	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%
VW	α_{2-1}	0.5%	-1.5%	-1.2%	0.4%	-0.9%	-0.3%	-4.5%	-0.7%	-1.1%	2.1%
VW	α_{3-1}	0.7%	-3.1%	-2.3%	-0.1%	-1.0%	-1.0%	-6.3%	-1.8%	-1.1%	0.1%
VW	α_{4-1}	-0.2%	-3.0%	-3.5%	-0.5%	-1.0%	-1.5%	-9.1%	-1.5%	-5.2%	-2.5%
VW	α_{5-1}	4.3%	-0.1%	0.4%	3.6%	2.4%	2.7%	-1.3%	1.7%	-2.7%	-0.7%
VW	α_{6-1}	1.9%	-2.7%	-1.2%	0.5%	0.4%	0.0%	-5.3%	-0.7%	-0.6%	-1.2%
VW	α_{7-1}	1.8%	-1.2%	0.1%	1.2%	0.1%	1.0%	0.6%	0.2%	-2.2%	0.8%
VW	α_{8-1}	1.2%	-3.2%	-1.3%	0.4%	-1.3%	-0.2%	-0.6%	-1.4%	-3.0%	-0.1%
VW	α_{9-1}	-0.7%	-2.7%	-1.1%	-1.3%	-1.3%	-1.1%	-3.4%	-1.5%	-2.2%	2.1%
VW	α_{10-1}	-3.3%	-4.3%	-1.8%	-3.1%	-4.5%	-2.9%	-1.7%	-3.9%	-2.0%	-1.5%
VW	(t^{α}_{10-1})	(-1.12)	(-1.45)	(-0.60)	(-1.05)	(-1.50)	(-0.96)	(-0.58)	(-1.29)	(-0.64)	(-0.54)
EW	α_{2-1}	2.0%	3.7%	2.9%	2.9%	2.4%	2.8%	1.6%	2.9%	3.0%	0.4%
EW	α_{3-1}	1.1%	2.6%	1.5%	1.8%	1.9%	1.6%	-1.9%	2.0%	1.9%	-1.4%
EW	α_{4-1}	1.3%	2.0%	1.4%	1.6%	2.4%	1.5%	-2.8%	1.8%	1.1%	-0.5%
EW	α_{5-1}	0.4%	1.8%	0.9%	1.1%	1.4%	1.0%	-3.7%	1.5%	0.3%	-0.2%
EW	α_{6-1}	0.6%	1.0%	0.5%	0.8%	1.8%	0.8%	-4.1%	1.2%	0.7%	0.0%
EW	α_{7-1}	-0.7%	-0.7%	-1.6%	-0.4%	0.0%	-0.6%	-6.4%	-0.1%	-1.3%	0.3%
EW	α_{8-1}	-0.7%	0.4%	0.1%	-0.6%	0.8%	-0.2%	-5.0%	0.5%	-0.1%	-0.7%
EW	α_{9-1}	-2.5%	-1.1%	-0.5%	-2.2%	-1.2%	-1.5%	-5.0%	-1.3%	0.2%	0.4%
EW	α_{10-1}	-1.4%	3.2%	1.8%	0.1%	1.1%	0.9%	-2.7%	1.9%	2.0%	0.3%
EW	(t^{α}_{10-1})	(-0.48)	(1.07)	(0.60)	(0.04)	(0.35)	(0.31)	(-0.91)	(0.62)	(0.69)	(0.09)

Table IA.5
Correlations Between Equity Duration Measures

Panel A reports time series averages of cross-sectional rank correlations (Spearman's correlations) for the firm-level characteristics using the full sample of firms included in the duration portfolios (from 1973 to 2016). All variables are defined in Section 1. Panels B and C report return correlations between value- and equal-weighted High-Low portfolios constructed based on the different equity duration proxies (from July of 1973 to June of 2017).

	PANEL A - Firm-level Characteristics			
	Dur	***EPP***	***llDur***	***DSS Dur***
Dur	1			
EPP	0.98	1		
llDur	0.82	0.87	1	
DSS Dur	0.67	0.68	0.57	1
BE/ME	-0.60	-0.64	-0.59	-0.64
	PANEL B - VW Returns on High-Low Portfolio			
	Dur	***EPP***	***llDur***	***DSS Dur***
Dur	1			
EPP	0.94	1		
llDur	0.82	0.88	1	
DSS Dur	0.54	0.59	0.56	1
BE/ME	-0.49	-0.54	-0.50	-0.73
	PANEL C - EW Returns on High-Low Portfolio			
	Dur	***EPP***	***llDur***	***DSS Dur***
Dur	1			
EPP	0.97	1		
llDur	0.90	0.93	1	
DSS Dur	0.81	0.85	0.77	1
BE/ME	-0.57	-0.64	-0.57	-0.76

Table IA.6
Performance of Duration Portfolios Based on *DSS Dur*: Keep Microcaps, no NYSE Breakpoints, and Winsorize Returns

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on *DSS Dur*, which is measured from equation 16 (empirical details in Section 4.2). These portfolios are constructed without using NYSE breakpoints, keeping microcaps in equal-weighted portfolios, and winsorizing returns at 1% and 99%. Panel A shows average returns (×12), volatilities (×$\sqrt{12}$), and Sharpe Ratios (×$\sqrt{12}$). Panel B reports αs (×12) and βs from factor regressions. Statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)) with t_{stat} in parentheses and p-value in brackets.

PANEL A: Average Returns, Volatilities, and Sharpe Ratios

Duration	Value-Weighted Portfolios						Duration	Equal-Weighted Portfolios					
Decile	$\overline{r}_{t\to t+1}$	$\overline{r}_{t\to t+5}$	$\overline{r}_{t+4\to t+5}$	$\overline{r}^{Large}_{t\to t+1}$	σ	$\overline{r}/\sigma$	Decile	$\overline{r}_{t\to t+1}$	$\overline{r}_{t\to t+5}$	$\overline{r}_{t+4\to t+5}$	$\overline{r}^{Large}_{t\to t+1}$	σ	$\overline{r}/\sigma$
Short	10.4%	11.3%	9.1%	9.6%	20.3%	0.51	**Short**	14.0%	14.7%	13.2%	10.6%	20.3%	0.69
2	11.8%	10.3%	9.9%	8.6%	17.7%	0.66	**2**	13.9%	14.1%	13.6%	9.5%	19.7%	0.70
3	10.4%	9.8%	10.1%	7.9%	17.3%	0.60	**3**	13.0%	13.7%	13.9%	9.8%	19.3%	0.67
4	10.6%	9.6%	8.5%	8.0%	16.5%	0.64	**4**	12.3%	13.4%	13.1%	9.4%	19.3%	0.64
5	8.3%	9.0%	9.1%	7.7%	16.1%	0.52	**5**	11.5%	12.3%	12.3%	8.6%	19.1%	0.60
6	8.9%	8.7%	9.2%	7.7%	16.5%	0.54	**6**	11.0%	11.9%	11.9%	8.9%	19.6%	0.56
7	7.9%	7.9%	7.1%	6.7%	15.7%	0.51	**7**	10.1%	11.4%	11.1%	7.5%	20.0%	0.50
8	7.6%	7.4%	8.0%	6.1%	17.0%	0.45	**8**	8.4%	10.4%	10.8%	6.9%	21.7%	0.39
9	7.1%	8.1%	10.5%	5.5%	22.1%	0.32	**9**	4.4%	8.9%	10.8%	6.3%	26.1%	0.17
Long	-0.7%	2.9%	6.6%	4.9%	27.1%	-0.02	**Long**	1.8%	7.9%	9.8%	4.9%	28.7%	0.06
L-S	-11.1%	-8.4%	-2.6%	-4.8%	20.5%	-0.54	**L-S**	-12.1%	-6.7%	-3.4%	-5.7%	14.4%	-0.84
(t_{L-S})	(-3.39)	(-3.55)	(-1.00)	(-1.41)	[0.00]	[0.00]	**(t_{L-S})**	(-4.67)	(-3.04)	(-1.50)	(-2.01)	[0.00]	[0.00]

PANEL B: Risk-Adjusted Performance Based on Factor Models

Duration	CAPM		Fama and French (2015) **5-Factors**						Hou, Xue, and Zhang (2015) **q-Factors**				
Decile	α_{CAPM}	β_{MKT}	α_{FF}	β_{MKT}	β_{SMB}	β_{HML}	β_{CMA}	β_{RMW}	α_q	β_{MKT}	β_{SIZE}	β_{INV}	β_{ROE}
						Value-Weighted Portfolios							
Short	2.5%	1.02	-1.4%	1.06	0.44	0.71	-0.21	0.08	2.0%	1.02	0.31	0.45	-0.33
2	4.5%	0.97	-0.1%	1.06	0.28	0.42	0.12	0.29	1.5%	1.03	0.18	0.55	-0.02
3	3.4%	0.97	-0.5%	1.05	0.22	0.41	0.03	0.26	0.7%	1.02	0.14	0.47	-0.02
4	3.9%	0.94	0.2%	1.02	0.17	0.21	0.21	0.26	1.7%	0.99	0.09	0.39	0.01
5	1.9%	0.91	-1.6%	1.00	0.11	0.12	0.27	0.30	-0.9%	0.97	0.04	0.40	0.08
6	2.2%	0.95	-0.6%	1.02	0.09	0.01	0.17	0.38	-0.4%	1.00	0.02	0.23	0.19
7	1.4%	0.93	0.2%	0.96	0.03	-0.19	0.24	0.19	-0.1%	0.94	0.03	0.02	0.18
8	0.4%	0.99	0.6%	0.99	-0.04	-0.31	0.14	0.18	0.3%	0.99	-0.04	-0.21	0.21
9	-2.0%	1.25	2.1%	1.10	0.06	-0.48	-0.16	-0.18	3.1%	1.13	0.01	-0.72	-0.12
Long	-10.8%	1.41	-7.8%	1.25	0.35	-0.28	0.10	-0.60	-5.7%	1.28	0.28	-0.23	-0.52
L-S	-13.3%	0.39	-6.5%	0.19	-0.10	-0.98	0.31	-0.68	-7.7%	0.26	-0.03	-0.68	-0.19
(t_{L-S})	(-3.54)	(2.76)	(-2.24)	(1.89)	(-0.54)	(-5.39)	(1.16)	(-2.76)	(-2.50)	(2.24)	(-0.15)	(-2.32)	(-0.64)
						Equal-Weighted Portfolios							
Short	6.8%	0.96	2.5%	0.92	0.91	0.47	0.03	-0.03	5.5%	0.88	0.77	0.51	-0.43
2	6.7%	1.00	2.2%	0.97	0.87	0.43	0.01	0.08	4.7%	0.93	0.72	0.47	-0.32
3	5.8%	1.00	1.5%	0.96	0.88	0.33	0.04	0.12	3.8%	0.92	0.75	0.35	-0.23
4	5.0%	1.02	0.9%	0.98	0.83	0.32	-0.01	0.17	3.2%	0.94	0.69	0.30	-0.21
5	4.0%	1.05	0.7%	0.99	0.78	0.21	0.00	0.15	2.4%	0.96	0.66	0.19	-0.14
6	3.2%	1.08	0.0%	1.03	0.76	0.14	0.05	0.14	1.7%	1.00	0.65	0.17	-0.13
7	2.0%	1.11	0.5%	1.02	0.71	0.03	-0.02	0.01	2.1%	1.00	0.62	-0.05	-0.17
8	-0.5%	1.21	-0.5%	1.07	0.71	-0.09	-0.06	-0.13	1.3%	1.06	0.61	-0.22	-0.27
9	-5.4%	1.34	-2.6%	1.08	0.87	-0.31	-0.02	-0.64	0.1%	1.09	0.79	-0.47	-0.63
Long	-7.7%	1.31	-7.2%	1.07	1.10	-0.04	0.14	-0.69	-3.0%	1.07	0.95	-0.04	-0.88
L-S	-14.5%	0.34	-9.8%	0.15	0.19	-0.51	0.11	-0.65	-8.5%	0.19	0.18	-0.54	-0.45
(t_{L-S})	(-5.19)	(4.38)	(-5.01)	(3.53)	(2.38)	(-4.42)	(0.63)	(-5.74)	(-2.85)	(2.54)	(2.15)	(-2.68)	(-2.40)

Table IA.7
Performance of Duration Portfolios Based on *Dur*
Keep Microcaps, no NYSE Breakpoints, and Winsorize Returns

Equity duration portfolios are formed every June (1973 to 2016) from deciles based on Dur, which is measured from equation 7 (empirical details in Section 1). These portfolios are constructed without using NYSE breakpoints, keeping microcaps in equal-weighted portfolios, and winsorizing returns at 1% and 99%. Panel A shows average returns ($\times 12$), volatilities ($\times\sqrt{12}$), and Sharpe Ratios ($\times\sqrt{12}$). Panel B reports αs ($\times 12$) and βs from factor regressions. Statistical inference is robust to heteroskedasticity and autocorrelation (Newey and West (1987, 1994)) with t_{stat} in parentheses and p-value in brackets.

PANEL A: Average Returns, Volatilities, and Sharpe Ratios

Duration	Value-Weighted Portfolios						Duration	Equal-Weighted Portfolios					
Decile	$\overline{r}_{t\to t+1}$	$\overline{r}_{t\to t+5}$	$\overline{r}_{t+4\to t+5}$	$\overline{r}^{Large}_{t\to t+1}$	σ	$\overline{r}/\sigma$	Decile	$\overline{r}_{t\to t+1}$	$\overline{r}_{t\to t+5}$	$\overline{r}_{t+4\to t+5}$	$\overline{r}^{Large}_{t\to t+1}$	σ	$\overline{r}/\sigma$
Short	12.1%	11.9%	11.5%	10.4%	21.0%	0.58	**Short**	15.9%	15.6%	14.2%	10.8%	21.5%	0.74
2	12.5%	11.3%	12.8%	9.8%	18.2%	0.69	**2**	14.1%	15.2%	14.0%	9.4%	19.8%	0.71
3	11.5%	11.0%	8.3%	10.7%	17.5%	0.66	**3**	14.2%	14.4%	13.5%	11.5%	20.0%	0.71
4	12.7%	11.4%	10.9%	10.6%	17.3%	0.73	**4**	13.3%	13.9%	13.6%	10.8%	19.7%	0.67
5	10.3%	10.2%	8.2%	6.0%	16.3%	0.63	**5**	12.0%	12.9%	12.6%	8.0%	19.4%	0.62
6	10.1%	8.6%	7.5%	6.6%	15.8%	0.64	**6**	10.4%	11.9%	11.6%	8.2%	19.6%	0.53
7	7.1%	7.5%	7.9%	5.7%	16.3%	0.44	**7**	9.3%	11.3%	12.2%	6.6%	20.5%	0.46
8	6.6%	6.9%	7.4%	5.6%	17.4%	0.38	**8**	7.5%	9.9%	10.5%	7.3%	21.4%	0.35
9	5.3%	6.4%	8.9%	4.8%	19.4%	0.27	**9**	4.6%	8.0%	9.5%	5.2%	23.0%	0.20
Long	1.7%	3.7%	5.5%	3.2%	23.3%	0.07	**Long**	-1.0%	5.5%	8.6%	4.7%	27.5%	-0.04
L-S	-10.4%	-8.2%	-6.0%	-7.2%	17.6%	-0.59	**L-S**	-17.0%	-10.1%	-5.6%	-6.1%	14.6%	-1.16
(t_{L-S})	(-3.41)	(-3.82)	(-2.42)	(-2.55)	[0.05]	[0.00]	**(t_{L-S})**	(-7.41)	(-4.73)	(-2.45)	(-2.43)	[0.00]	[0.00]

PANEL B: Risk-Adjusted Performance Based on Factor Models

Duration	CAPM		Fama and French (2015) **5-Factors**						Hou, Xue, and Zhang (2015) **q-Factors**				
Decile	α_{CAPM}	β_{MKT}	α_{FF}	β_{MKT}	β_{SMB}	β_{HML}	β_{CMA}	β_{RMW}	α_q	β_{MKT}	β_{SIZE}	β_{INV}	β_{ROE}
						Value-Weighted Portfolios							
Short	4.3%	1.01	-0.8%	1.02	0.80	0.39	0.19	0.11	1.4%	0.97	0.69	0.52	-0.22
2	5.4%	0.94	1.2%	0.96	0.58	0.23	0.17	0.22	3.0%	0.91	0.49	0.34	-0.07
3	4.6%	0.95	2.1%	0.94	0.46	0.16	0.02	0.14	3.2%	0.91	0.39	0.12	0.01
4	5.8%	0.95	3.1%	0.98	0.30	0.18	0.01	0.26	4.0%	0.94	0.24	0.15	0.07
5	3.5%	0.94	1.2%	0.99	0.11	0.05	0.14	0.23	1.5%	0.97	0.08	0.16	0.14
6	3.8%	0.90	2.0%	0.94	0.12	-0.18	0.34	0.16	2.3%	0.91	0.11	0.07	0.13
7	0.2%	0.96	-0.4%	0.97	0.02	-0.07	0.05	0.15	-0.3%	0.97	-0.01	0.00	0.10
8	-0.7%	1.03	-0.8%	1.03	0.00	-0.13	0.11	0.04	0.5%	1.02	-0.06	-0.07	-0.06
9	-3.1%	1.15	-2.8%	1.12	0.11	-0.10	-0.10	0.11	-2.0%	1.12	0.05	-0.23	0.06
Long	-7.9%	1.34	-5.0%	1.22	0.13	-0.17	-0.10	-0.37	-4.2%	1.25	0.12	-0.29	-0.27
L-S	-12.2%	0.32	-4.2%	0.20	-0.67	-0.56	-0.29	-0.49	-5.6%	0.28	-0.57	-0.81	-0.06
(t_{L-S})	(-3.20)	(3.60)	(-1.75)	(2.71)	(-5.05)	(-3.80)	(-1.76)	(-3.70)	(-2.03)	(4.21)	(-4.14)	(-4.18)	(-0.31)
						Equal-Weighted Portfolios							
Short	8.8%	0.96	4.5%	0.89	1.04	0.42	0.09	-0.09	7.4%	0.85	0.90	0.47	-0.46
2	7.0%	0.97	3.2%	0.90	0.95	0.33	0.00	0.04	5.8%	0.86	0.81	0.30	-0.33
3	7.0%	1.02	3.7%	0.94	0.92	0.28	-0.02	0.02	5.8%	0.91	0.79	0.22	-0.26
4	5.7%	1.05	2.9%	0.96	0.86	0.22	-0.01	0.02	4.8%	0.93	0.75	0.16	-0.24
5	4.4%	1.07	1.5%	1.00	0.78	0.15	0.05	0.06	3.4%	0.97	0.68	0.14	-0.19
6	2.6%	1.09	0.3%	1.01	0.74	0.14	-0.03	0.04	2.4%	0.98	0.62	0.07	-0.23
7	1.1%	1.14	-0.5%	1.04	0.72	0.12	-0.08	-0.01	1.4%	1.03	0.61	0.01	-0.23
8	-1.2%	1.18	-2.8%	1.08	0.75	0.03	0.03	-0.05	-0.4%	1.06	0.63	0.00	-0.29
9	-4.6%	1.25	-5.4%	1.12	0.77	-0.04	0.04	-0.17	-3.1%	1.12	0.64	-0.03	-0.38
Long	-10.9%	1.35	-9.5%	1.12	0.90	-0.13	0.10	-0.65	-6.1%	1.13	0.77	-0.13	-0.77
L-S	-19.7%	0.39	-14.0%	0.23	-0.14	-0.55	0.01	-0.56	-13.5%	0.28	-0.13	-0.60	-0.31
(t_{L-S})	(-7.45)	(4.60)	(-6.66)	(4.22)	(-0.96)	(-2.80)	(0.05)	(-4.01)	(-5.79)	(4.49)	(-0.90)	(-3.34)	(-1.52)